What's ahead

Information, Please!

In your opinion, what company in the chemical process industries has contributed the most meritorious advance to the industry and profession since 1937? What has been that company's attitude toward research? Toward its technical men? To what extent have chemical engineers participated in its progress? . . . These are questions that must be answered before October next by a distinguished Committee on Award for Chemical Engineering Achievement. It wants and needs your advice.

You can also help with the big job outlined on page 337 of this issue. The next edition of "Facts and Figures of American Chemical Industry" must be a truly cooperative effort. What are your suggestions? — Editor.

•

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CHEMICAL & METALLURGICAL ENGINEERING

Volume 46 • Established 1902 • Number 6

JUNE 1939

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Cover picture shows several of the stills in the plant of the Pennsylvania Alcohol Co. Other illustrations appear in the pictured flow sheet on pages 365–368 of this issue. [*This cover space released for editorial use by the Pfaudler Co.*]

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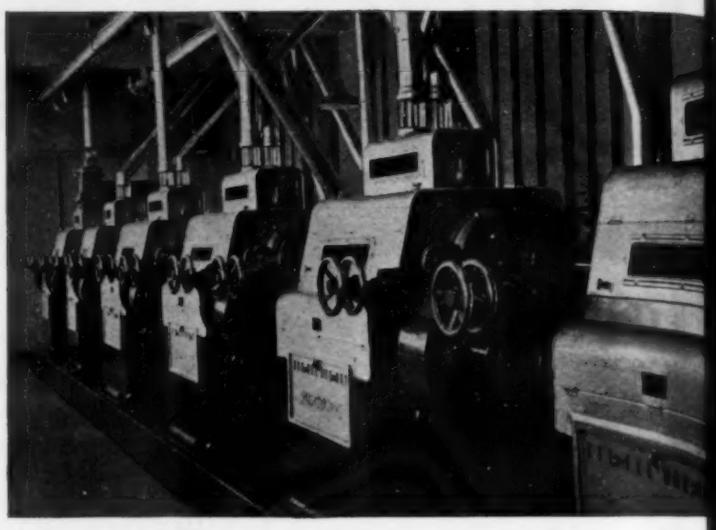
Here's How Processors Are Getting EXTRA YIELD WITH UNIFORM, MODERN-METHOD GRANULATION!



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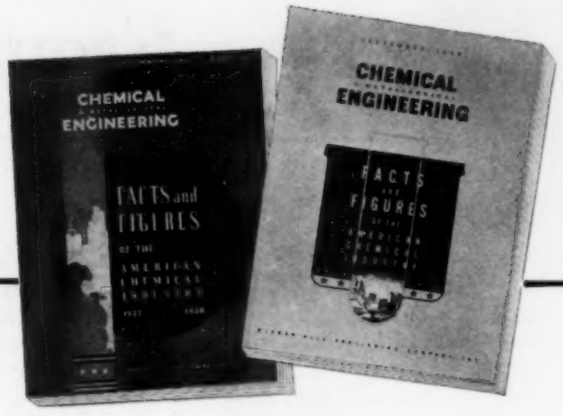
ESTABLISHED 1902

JUNE, 1939

S. D. KIRKPATRICK, *Editor*



Our Public Responsibilities

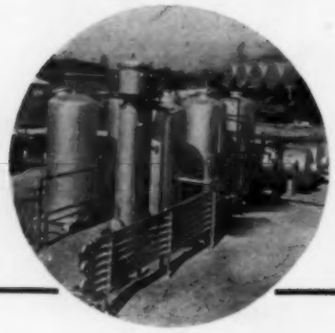
TODAY CHEMICAL INDUSTRY is very much in the public eye. More than any other it typifies the magic age of science in which we are living. The layman has come to expect miracles to spring from the test tubes of the research chemist—to grow overnight into immensely profitable enterprises that supply us with new medicines with which to live or poison gases and explosives with which to promote destruction. To him we are a strange mixture of good and bad intents and influences.

We pay the penalties for leadership in our technical progress. Despite the fact that millions find work in new industries developed through scientific research, we are charged with creating technological unemployment. We produce new synthetic materials from coal, limestone, salt, even from the air itself—that prove of immense benefit to mankind. Yet in doing so we displace some of the products of nature, we disrupt foreign trade, we disturb the "status-quotians" with our accelerated obsolescence of established practices, processes, plants, equipment, markets, customer and consumer demands.

The public attitude toward the chemical industry is a matter of vital concern to all of us. Legislation and regulations as well as punitive and confiscatory taxes are some of the penalties that burden our progress. What can we do about it? Public education is a slow and discouraging process but nevertheless a vitally necessary one. As an industry we made a start in September, 1937, with the publication of the first "Facts and Figures of the American Chemical Industry." It puts into the hands and minds of many the basic factual information that is essential to obtaining a better understanding of us and our work. Yet it was only the beginning of what must be a continuing process.

American chemical industry is far from static. Its progress and achievements are matters of interest and concern to people in all walks of life. Its statistics are necessary yardsticks with which to measure the trends of profitable business in both security and commodity markets. Even within the industry itself and among its customers there is pressing need for more timely data on production and consumption, distribution and price trends. What becomes of the chemical dollar? How much goes for raw materials, wages and salaries, research, interest and taxes? Authoritative answers to such questions will help to dispel many of the myths and half-truths regarding chemical industry that have grown up through the lack of adequate knowledge of its fiscal affairs.

Recognizing the importance of these public responsibilities of the chemical industry, *Chem. & Met.* proposes to publish in September, 1939, a complete revision and expansion of its original "Facts and Figures of the American Chemical Industry." The work of preparation is already under way, encouraged by the interest and cooperation of the oldest and most representative trade association in the field. However, the job is one that calls for even wider interest and support. Every *Chem. & Met.* reader who feels that he can contribute suggestions, comments or criticisms is urged to do so. We all stand to gain through increased knowledge and better understanding of chemical industry.



From an

IS THIS A TAX DEPRESSION?

ANNUAL REPORTS of representative petroleum refineries show, in many instances, that the amount of money paid and collected in taxes in 1938 actually exceeded the total payrolls. In practically all cases taxes were in excess of the dividends paid to stockholders—often by several times as much. On the average, taxes amounted to about 50 per cent of the net prices received for petroleum products.

One may argue that all these taxes are passed on to the consumer, that industry merely serves as tax collector. Yet we know that higher taxes mean higher prices and in turn, lower purchasing power of wages, reduced payrolls and diminished returns to security holders. There is encouraging evidence that some of these fundamental facts about business are becoming better understood in the Halls of Congress. Led by able Senator Harrison, a group of business-minded legislators has compelled the President to consent to a constructive effort toward tax revision. But there is nothing sure about this revision until the bill is passed and becomes a law, with or without signature.

We are told that we can be most helpful to the chairmen of the Ways and Means Committee of the House and the Finance Committee of the Senate, if we provide them with specific information about any chemical or process industry that will go ahead under lower taxes but cannot make much progress under present conditions. Let's prove, if we can, that taxes are more than an incidental factor in the depression that followed the recession!

EVER-CHEAPER ENERGY

MANY OF THE OUTSTANDING gas engineers of the country met last month in Rochester to discuss the production and chemical problems of the manufactured gas industry. Despite the tremendous invasion of natural gas into the utility field, these men are still contributing much new technology for the making of better, cheaper fuel gases.

Today it is possible in many parts of the country to buy energy in the form of liquid and gaseous fuels at unbelievably low rates. In certain areas the cost of electric energy generated from these fluid fuels is actually much lower than the cost of power at practically any hydroelectric plant that could still be built in useful parts of the United States. This means that chemical enterprise needing such energy either as fuel or as electricity may continue to count on increased economies.

In one locality of which we have editorial information, there is talk about fuel-generated electric power at 1½ mills or even 1 mill per kilowatt hour. Even the best hydro properties cannot talk more persuasively than that. The geography of such situations is not always ideal. But so long as these new opportunities do exist, power-using enterprises, which means most of chemical process industries, must continuously be alert to new opportunity, new locality and new processes made practical by cheap energy supply.

STILL STALKS THE GHOST

FOR REASONS not entirely technical or economic, the government refuses to abandon the study of the manufacture of alcohol for motor fuel, using farm products as raw material. There are at least two evidences of renewed interest in Washington today:

1. Supposedly responsible technical people are again arguing that Congress should waive the Federal tax on gasoline containing such alcohol—following the example of England in thus subsidizing its gasoline made from British coal. In the face of the demand for a more equitable tax structure, it does not seem likely that Congress will use its legislative power to support this type of chemurgic enterprise. But it does show that the ghost of "alky gas" still stalks the land.

2. The Department of Agriculture admits that it must put up a semi-works unit for motor fuel alcohol experimentation at its new Peoria (Ill.) Regional Research Laboratory. We had hoped for more fundamental research with the money to be spent there. But it must be realized that political pressure to this end from corn-state Congressmen is almost irresistible.

All this means a continuation of the politico-chemical battle to secure a share of the motorist's gasoline dollar. It sets at naught all we have learned to date about the economics of this inter-fuel competition.

Editorial Viewpoint

MOST CHEMICALS ARE FOODS!

IT IS NOT QUITE TRUE that all chemicals *are* foods; but it is true that almost any chemical may become a food under the law. And when it does it must meet the drastic regulations of the new Federal Food, Drug, and Cosmetic Act which becomes effective shortly. Few makers of chemicals have adequately understood how comprehensive that law is. It applies to any commodity which may be purchased by a food, drug, or cosmetic manufacturer to become an ingredient or component of a drug, cosmetic, food or beverage for the use of man or animals. And such goods are subject to seizure, and the shippers who send them into interstate commerce are subject to fine and imprisonment if there be either adulteration or misbranding.

The Food and Drug Administration officials are initially taking a most literal interpretation of the terms of the new law. They will ultimately, and one may hope soon, give greater emphasis to the spirit of the Act than to the details of its phrasing. Nevertheless, at the outset there is chance of embarrassment, if not actual dollar penalties, to chemical makers who do not get copies of the Act and regulations and study them with great care. It is well to be well prepared.

An orgy of relabeling may be expected before the Act is fully enforced. Pending such relabeling it is going to be necessary for manufacturers to use suitable precautions as to how, when, and whether to sell their goods to the makers of foods, drugs, and cosmetics.

A SHARE-THE-FACTS CAMPAIGN

ALMOST EVERY READER of *Chem. & Met.* knows of one or two places where some new money might wisely have been ventured if the political hazards imposed lately had not been so great. It would be a fine thing to emphasize these specific examples to the members of the Congress in whose districts the enlarged activities might have occurred.

These members of Congress need to know real facts. They would like to do something about these specific cases that affect their constituents. If they are given enough encouragement they will vote for legislation that may guard against continuance of a critical attitude toward industry on the part of certain federal officials.

Among the things which these members of Congress may well be asked to do are: Limit further governmental controls beyond those needed to correct real abuses; restore tax laws to the basis of revenue rather than reform; strive for governmental economy without such parsimony as will cause actual distress; re-establish a constructive, cooperative relation between labor and management; impose restraints on the reformers in the executive departments who are neither practical in their experience nor effective in serving those under-privileged whom they claim to aid.

If Congress does not know the facts, it cannot be expected to act constructively. In chemical industries are many who can supply these facts which can and should be shared with our representatives in Washington.

"SOULLESS CORPORATION?"

WE ARE INDEBTED to Jay Taylor, the Cleveland newspaper columnist, for an editorial that belongs in our public relations series for the chemical process industries. May we quote from the gossip of "Our Town":

> Once in a while we hear that such-and-such a company is a "soulless corporation." I know one that's not. It kept C. J. "Farky" Farcasin on its payroll for nine long years while he was fighting tuberculosis. He's back in Cleveland now and the fight is won.
>
> In the fall of 1929 Farcasin had to drop his work as local manager for the Stauffer Chemical Co., a national concern. He was a big strapping fellow—had played stellar football at West Tech and Ohio State—but tuberculosis often hits big, strapping fellows hardest.
>
> He went to Colorado Springs. He had four major operations, spent six years flat on his back. Once he was given three months to live. The pay checks kept coming. I met him today. His face is sun-tanned. In his clothes are 190 pounds of healthy man. And in his heart there is gratitude. * * * He didn't want to talk about Farcasin. Wanted to talk about the corporation with a soul. I don't wonder.

Neither do we. Sometimes in the past we have been a little bit critical of Messrs. Stauffer because they wouldn't let us write articles about some of their plants. We apologize.

Chemical Labor Relations

Paternalism and arbitrary rule are passing from the industrial labor scene in favor of cooperation between employer and employee based on understanding, confidence and mutual respect. Oftentimes the chemical engineer assumes the role of go-between.

PUBLIC RELATIONS for CHEMICAL PROCESS INDUSTRIES

JOHN R. STEELMAN *and* HENRY G. BAKER

Director and Commissioner, respectively, of Conciliation
United States Conciliation Service
Washington, D. C.

AMERICAN CHEMICAL INDUSTRY commands the respect of the world for its outstanding developments. Likewise, it should command the respect of everyone for its record in promoting and maintaining industrial peace. The industry has been comparatively free of serious labor difficulties when compared with some of the other industries. Immediately the question is, why? Is it because of the lack of concerted unionization? Is it because the majority of chemical plants have a functioning public relations department? Is it because of a higher type of employee that results in a higher wage? Or, is it because the personnel of the chemical industry is to a great extent under the supervision and direction of trained engineers?

Informed persons seem to feel that this latter reason is the real one. Again the question, why? Engineers deal with facts and have a reason for their action based on fact and experience. The average worker in a plant has confidence in the engineer's ability and respects him for his knowledge of what causes the process to function properly.

Strikes and lockouts are not causes of industrial unrest, they are outward signs that someone has failed to do his job properly, that discussions have stopped and that economic warfare has been declared. The public has an interest in such warfare and the Government represents the public. The United States Conciliation Service is the Governmental agency representing the public's interest in labor relations and has been engaged in improving, promoting, and maintaining proper employee-employer relations for over a quarter of a century.

One of the principal characteristics of the Conciliation Service that distinguishes it from most Governmental agencies, is that it has no law to enforce, has no power of compulsion, and utilizes no coercive methods in its work. Through this agency the Federal Government offers a service without cost to the interested parties, acting to bring harmony out of discord and to supplant labor disturbances with peace obtained at the conference table. Commissioners of Conciliation are its industrial peace makers; their power lies solely in knowledge, experience, and persuasiveness and their goal is the establishment of cooperation and good will between employee and employer.

The Conciliation Service starts with the basic facts which President Wilson stated many years ago. "A settlement is never impossible when both sides want to do the square and right thing. . . . . A settlement is always hard to avoid when the parties can be brought face to face." Possibly it was because a large number of employers did not want to do the "square and right thing" and refused to meet representatives of the workers "face to face" that the National Labor Relations Act was passed.

The chemical industry ranks far down the list of industries with labor difficulties. During the fiscal year 1937–38 (July 1, 1937–June 30, 1938), the U. S. Conciliation Service disposed of 4,231 situations involving 1,618,409 workers, and of that number only 47 situations involving 9,868 workers were classified industrially as chemical. During the first half of the fiscal year 1938–39 (July 1–December 31, 1938), this agency disposed of 1,775 situations involving 746,152 workers with an average of 420 workers per case. For the same period, there were only 21 cases involving 3,176 workers

This article is taken from a paper entitled "Labor Relations in the Chemical Industry" presented at the Akron meeting of the American Institute of Chemical Engineers.

disposed of in the chemical industry and these averaged only 151 workers.

The question arises as to what causes labor disputes. The list of causes would be almost endless, but experience has shown the major issues to be: hours, wages, working conditions, and union recognition. Many subdivisions could be made under each, but an analysis of each type would be about the same.

Sometimes it is difficult to see just why employees strike. Perhaps some of the case studies given below will throw light on the subject and provide an insight into some of the reasons.

Case Studies

In two situations involving a large number of workers, the strikes were called because management allegedly refused to bargain with the union. The basis for the refusal was the belief that the union did not represent a majority of the workers; yet in both cases the companies refused to allow a consent election to either prove or disprove their contention. In both cases the companies' attitude forced a National Labor Relations Board hearing, and after the hearing an election, thus causing considerable expense whereas a consent election would have accomplished the same results.

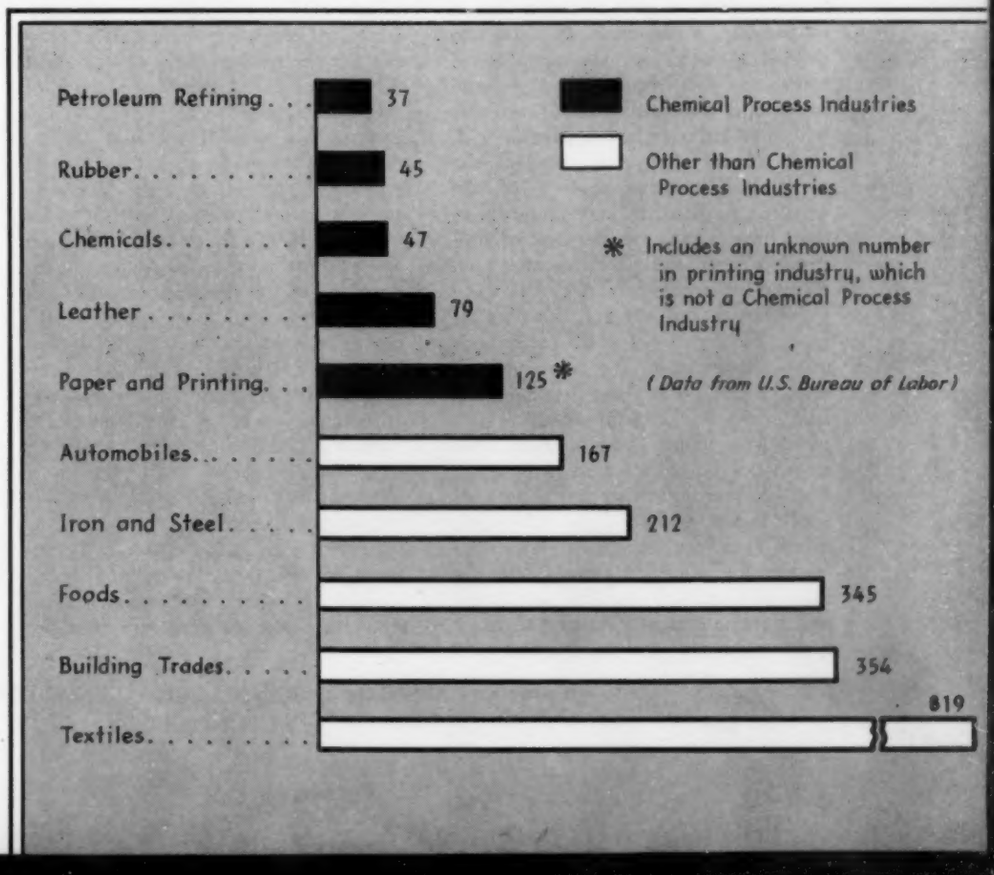
A campaign was started to organize the employees of a certain chemical plant. The plant had been in operation for about 20 years without requiring a physical examination for its employees. As soon as the organization drive started the company decided to have all employees examined and all who failed to pass were to be released. Naturally the employees were alarmed by the new ruling since it coincided with unionization and when management insisted on inserting the medical examination clause in the contract, they struck. Another contributing factor to arouse the suspicion of the workers was that the company doctor, who would hold the fate of a man's job, happened to be the son of the president of the company and there was to be no appeal from this doctor's findings. A Commissioner of Conciliation found that many of the employees would be discharged under the new plan in spite of the fact that they had many years of satisfactory service and were physically able to do the job assigned.

A settlement was finally worked out to the effect that all new employees had to be physically fit on entering the company's employ and that all of the present employees would be examined by the company doctor with the proviso that if an employee felt the diagnosis wrong, the case could be appealed to the State Health Department and their findings would be final and binding. It was also agreed that should the company doctor find some physical defect that could be cured and the employee took advantage of treatment and was cured he would be retained. Perhaps the physical examination program just happened to coincide with the organization of the plant, but on the surface it appeared to be a well thought-out plant to get rid of the union employees by merely declaring them physically unfit without an appeal. The settlement provided the much needed physical examination of the employees, but safeguards were set up against its abuse.

The president and board of directors may formulate a company's policy, which may be excellent. However, this policy by the time it has passed through several executives, a manager, a superintendent, a foreman, and a section foreman, and finally received by the workers, is nothing like the original. Each man through whose hands it has passed has placed his interpretation upon it. A strike situation might illustrate the point. The executives of a chain of mills decided to make some changes in operating procedure which on the surface indicated a decided overload on the employees. They realized it, so it was made clear in their specifications to the plant managers that the same fatigue relief factor as before the changes would be guaranteed and that there would be no reduction in wages. When the machinery was installed and the assignment changed the employees struck. The company executives told the employees the plant manager had full authority to act and they would have nothing to do with the case. After weeks of idleness and disinterested attitude on the manager's part, one of the company executives was prevailed upon to meet with the employees' committee. In this meeting the whole affair was discussed and it developed that the manager had not informed the employees of the guarantee of no overload or reduction in pay. When the committee found out the truth they pointedly told the executive had they been informed as to this policy, the strike would never have occurred. The manager was furloughed for he admitted not telling the full story to the employees and his reason was that he didn't feel it was any of their business. He felt his orders were not to be questioned. The new manager reached an agreement immediately and the plant resumed operations. Three months of time had been lost and orders cancelled just because the company plan was not explained to the workers.

In this same situation another interesting thing came up. The company had two plants in this Southern city.

A breakdown by industries of part of the labor situations disposed of by the United States Conciliation Service during the fiscal year ended June 30, 1938


Petroleum Refining . . . 37
Rubber 45
Chemicals 47
Leather 79
Paper and Printing . . . 125 *
Automobiles 167
Iron and Steel 212
Foods 345
Building Trades 354
Textiles 819
Chemical Process Industries
Other than Chemical Process Industries
* Includes an unknown number in printing industry, which is not a Chemical Process Industry
(Data from U.S. Bureau of Labor)

One plant had had some labor difficulties a number of years before and it looked as though the company would have to shut down because no manager was able to keep the personnel content. Finally, in shifting managers around, a man who knew local conditions and personnel was made manager, and almost at once unrest ceased. Why? Conditions were the same as under former managers but when the workers were asked, their reply was, "He talks our language and when we say something can't be done and he says it can, then we know it can, for he will come into the plant and show us. You can't argue with a boss like that. He knows." When the second plant was down, the first plant kept running even though the employees were members of the same union. When the second plant's manager was discharged he was replaced by one who knew conditions and everything ran smoothly again. Remember the employees of this plant did not strike against the manager and neither did they request his dismissal, for it was a surprise to them. The new man did "talk their language" and that meant a great deal. Some executives who have plants in one section of the country and contemplate moving to other locations might find it wise to keep this example in mind, for the cited condition is often at the bottom of considerable unrest while on the surface the reasons appear to be everything except the executive in charge.

An employee's income is another problem that causes unrest. All employees want as much as possible. Some employers want to pay as much as possible, while others still want to pay as little as is necessary. Since wages and cost of production go hand in hand, it is essential that labor costs within an industry be comparable with each other, taking into account the work load and production of the worker. A plant, to stay in business, must have labor costs per unit of production comparable with competition. Employees frequently ask for wage adjustments and are told the plant is losing money and a wage increase is out of the question. Too many employers feel that a statement that money is being lost is the final answer. If a plant loses money, why shouldn't the employees be shown that it is being lost A mere showing of a balance sheet is not sufficient, for these are difficult to understand and fail to answer the question. Several companies have realized that the employees and stockholders are entitled to know more about their company; so the annual statement has been simplified in order that the layman can more readily understand it. Employees working with the processes daily learn quite a bit about them, and, more often than not, they can make suggestions for more efficient operation which would result in lower production costs. The employees and direct labor costs cannot be considered except together, and since wages affect the morale and well-being of the employee as well as labor costs, the cost problems should be discussed with the employees. There may be something other than the wage scale out of line. The following instance might illustrate the point:

A company operated two plants, one in New York and the other in New Jersey. Due to the labor costs, the product was out of line in price; so business was being lost. Without a word to the employees and before asking their suggestions, notices were posted that wages were to be reduced 10 per cent in the New York unit and 7½ per cent in the New Jersey unit. Efforts were made by the employees to halt the reduction but they were not given a chance; so a strike was called in both plants. Negotiations were deadlocked until a Commissioner of Conciliation entered the situation and suggested the possibility of work load or job assignments being unbalanced instead of wages. Management knew labor costs had to be reduced, and all they had considered was wages; however, they agreed to pay wages that would make their labor costs per unit comparable with those of similar plants and would operate with comparable job assignments. The employees returned to their jobs to await the adjustment. A survey was made of the industry and it was found that job assignments were further out of line than were wages. In a joint meeting of employees and employer the data were presented and within an hour the whole problem was adjusted. The job assignments were adjusted on a comparable basis to the satisfaction of all, with the result that the proposed 10 per cent reduction was reduced to 1 per cent, which made the wages comparable. In the New Jersey unit the adjustments resulted in a 5 per cent reduction instead of the proposed 7½. The workers knew the jobs were out of line, but management admitted they had never once thought of improper job assignments being responsible for their labor costs being high. The parties reached an agreement, for they realized their jobs depended on the company staying in business and the company could not stay in business unless they were able to compete in the market. Had management talked to the employees and gotten their view before posting the wage reduction notices, there is no doubt that the employees could have pointed out a number of places where costs could be reduced before wages were slashed.

The question of working conditions arises and covers many items such as job assignments, health hazards, ventilation, holidays, vacations, etc. The job assignment problem has been discussed, but on this one issue alone, more free consultation with employees will be of greater value than can be estimated at a glance. Individual plants have their special problems. However, it is believed that if a supervisor would ask an employee from time to time for suggestions about his or her job, a better spirit would be developed. Certain jobs place a strain on the employee which if kept up over a period of time, would impair his health. Vacations are becoming more common in industry, but not so many years ago very few companies gave their plant operatives vacations. It is believed that vacations are contributing much to the betterment of employee-employer relations.

In the United States there have been two methods of dealing with employees; one of paternalism and the other of arbitrary rule. Unfortunately these two methods still exist, but they are rapidly passing in favor of co-operation between the employee and employer based on understanding, confidence, and respect. Employees can no longer be considered just human beings to carry out the foreman's orders; they must be heard and considered as thinking men and women whose cooperation is essential. No plan works until the employees understand it. Management must have patience and explain until an understanding is reached.

Since an engineer leads an active life and does constructive work, he is usually positive in his ideas and has a bright outlook for the future. The chemical engineer should be the key man in a labor relations program in a chemical plant. Management is successful only as long as it is fair; so if the program of labor relations is headed by an engineer, the plant is fortunate, for in every instance the real engineer has a high personal code of ethics backed up by his professional code.

Problems in Process Development

These engineers devised interesting means for solving the many problems in the design of equipment for the production of low-temperature coke. Their solutions may help others in overcoming difficulties in development of processes.

C. E. LESHER
and
A. A. ARCHER

President and engineer, respectively
Pittsburgh Coal Carbonization Co.
Pittsburgh, Pa.

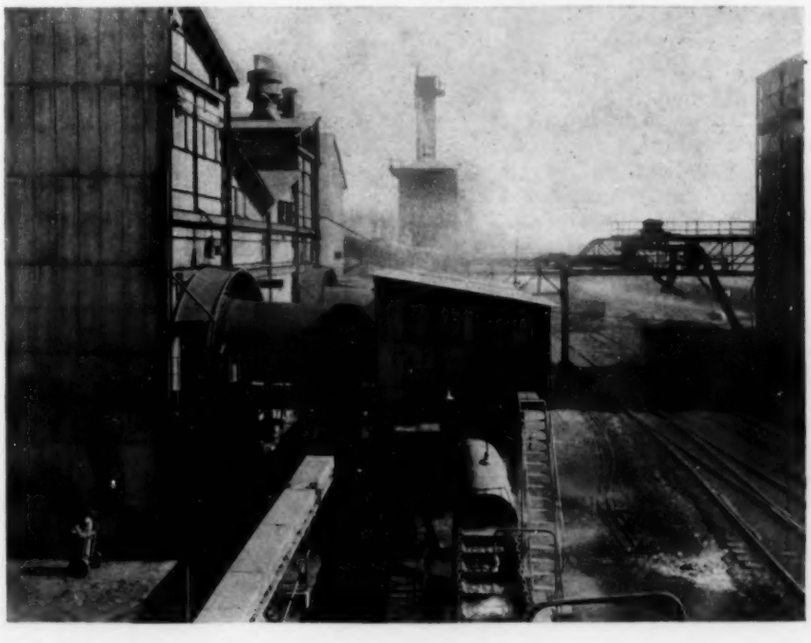
TEN YEARS AGO the Pittsburgh Coal Co. began experimenting with low-temperature carbonization of bituminous coal to find a use for the fine material obtained as a byproduct at its coal cleaning plants. The development work has proceeded cautiously over these years because of the disastrous failures of previous attempts not only here but abroad to make low-temperature coke in a marketable and commercially profitable form. After investigating many processes, two types of equipment were tried in pilot plants. The first of these was an intermittent oven and the second was a continuous retort. In both of these attempts there arose problems of metal expansion. This article sets forth some of the problems that were met and the more important results of this aspect of the work.

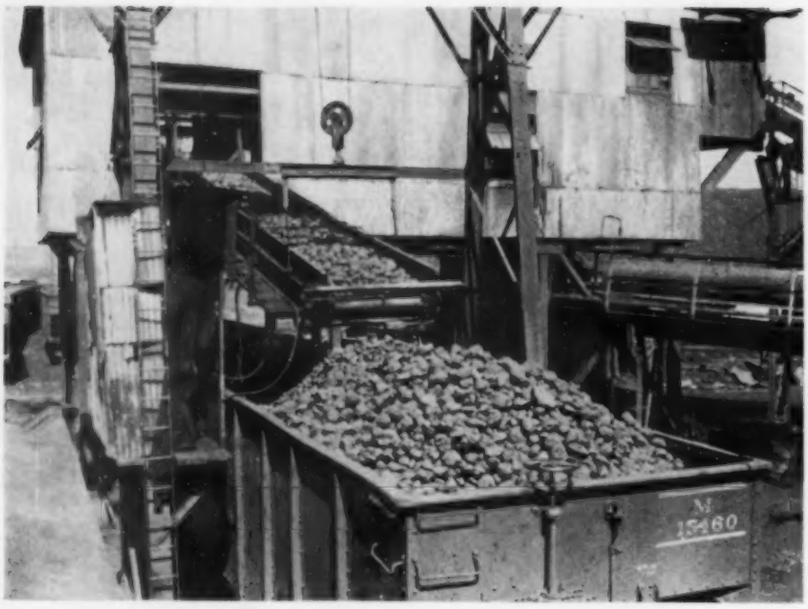
The intermittent type of oven was not carried beyond the first pilot plant and the metal expansion problems encountered are not recited here due to lack of space. The continuous type of process has been developed to the commercial stage. Most of the work and the more important experimental results discussed in this article have to deal with that method of operation.

The economics of low-temperature carbonization requires sturdy equipment that is not costly per ton of throughput, which means design that permits the use of ordinary steel. The continuous process that has been developed by the Pittsburgh Coal Carbonization Co., a subsidiary of the Pittsburgh Coal Co., is based upon the Wisner patents. Using a coking coal from the Pittsburgh bed this process first takes fine coal, minus ¼ in., through a drying and roasting stage to modify the coking properties, then through a mixing and storage stage and finally to the rotary retort where the fine, dry material is melted into balls and delivered as a solid, smokeless fuel. The maximum metal temperatures are between 900 and 1,000 deg. F. However, the whole system is under heat and subject to expansion in varying degrees and, because the heating gases are in a closed circuit protected by insulation, seals and expansion joints are of major importance in design.

A diagrammatic outline of the standard apparatus showing the temperature ranges on each piece of equipment is shown. In the furnace the products of combustion of the gas burners are mixed with the return of partially cooled combustion gas, to a regulated, controlled temperature of 1,040 deg. maximum. The fluctuations above and below the average are about 20 deg. so that the actual working temperatures of the heating gases leaving the furnace are from 1,000 to 1,040 deg. This is the temperature of the heating gas when it first meets the steel of the rotating carbonizer and is the maximum temperature of gas on the steel. The longest carbonizer in use under heat is 110 ft. and the heating gas progresses along that carbonizer through a circular orifice of 5⅞ in. During its passage up the carbonizer the heating gases are reduced in temperature approximately 150 deg. to 890 deg. maximum. Following the design of the inventor, Wisner, the pilot plant built by the company in 1932 was constructed with the two shells of the carbonizer as an integral unit, both revolving. The first unit of com-

Disco leaves carbonizers at this end of plant. The discharge end of unit lies between the building on the left and the shed in the center





Furnace size Disco being loaded at screening plant

mercial size built by the company was 6 ft. in diameter by 90 ft. in length, and was of the same design. The problem of having these two shells tied together and yet one of the shells expanding more than the other was the most serious problem encountered in this unit. The change in design so as to have only the inner shell revolve and to have the outer shell stationary, simplified the problem. Some of the difficulties of the two concentric revolving shells will be described later.

The heating gases leaving the upper end of the carbonizer at about 870 deg. pass through a duct to the roaster or are in part bypassed through the storage conveyor and by ducts back to the inlet of the booster fan, entering the fan at about 700 deg. F.

One of the important objectives is to have a plant that can be easily and safely shut down and reheated and this means that all equipment must be provided with easily accessible and fairly tight expansion joints and, where the revolving shell is involved, rotating seals that will handle hot gases up to about 4 in. water gage maximum pressure. With the design of carbonizer having the fixed and stationary outer shell, there are but two revolving seals on the unit. With the double wall revolving shell four seals were necessary. Expansion of straight line ducts is handled with a slip joint packed with rock wool. Expansion of the revolving drum is taken care of on the trunnion rollers that carry the rotating unit and in the seals at each end. Straight line ducts and straight line units such as the roaster are built on a track and the expansion is automatically taken care of in the linear direction by wheels or rollers.

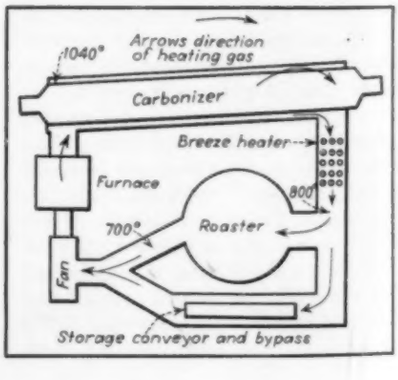
The insulation finally adopted is rock wool. When used under cover the bats are applied directly to the stationary shells of the ducts and fan casings and are covered with a plastic cement which serves to keep dust out of the wool and also to cover the joints between the bats. On the revolving units the only practicable application is the rock wool in the form of a mattress bound with wire on either side and the whole wrapped with steel wire and covered with plastic.

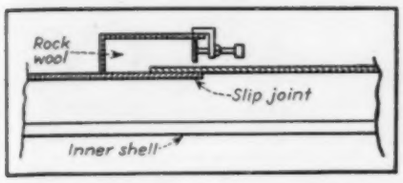
Operation of the pilot plant revealed that several serious errors had been made in the design. The most glaring of these was the method of attaching tire to shell. Heating would result in a temperature increase of 90 deg. F. in outer shell and perhaps 100 to 150 deg. in tires. Resulting differential expansions caused crushing of the outer shell under the tire blocks. On cooling, the mass of outer shell not under tire blocks was so much greater than the mass under blocks that contraction would tear rivet heads off blocks or shear metal adjacent to rivets. Thus every shutdown required a major repair job, conditions being worst where operating temperatures were highest. Seal design was deficient. Magnesia block insulation on the rotating shell was impossible to maintain.

Since heat flowing through the inner shell, doing useful work was greater than that through the insulated outer shell it follows that the outer shell was hotter than the inner shell and, therefore, the same conditions existed between inner and outer shells as was plainly visible between outer shell and tires. Calculations indicated that the outer shell under operating conditions averaged 100 deg. hotter than the inner shell. This means that 40 ft. of outer shell, if free to move relative to the inner shell, would expand longitudinally $\frac{3}{8}$ in. more than 40 ft. of inner shell to which it was attached by the separators. There would also be a differential expansion radially of the order of 0.05 in. If connections did not fail it was obvious that resulting stress would be distributed among various parts in inverse ratio to their masses—if moduli of elasticity of various parts were the same. Failure of weld did occur between outer shell and separators. When the carbonizer was finally dismantled it was seen that every separator at both ends of outer shell had broken away. Further, permanent growth had taken place, as points originally in contact were displaced relative to each other both radially and longitudinally. Radial displacement was much greater proportionately than longitudinal displacement. The actual displacement was $\frac{1}{8}$ in. longitudinally in 20 ft. Other separator welds failed but complete examination was not made as the problem was becoming clearer. Differential expansion must be taken care of if satisfactory life was to be obtained. Better seals must be designed not only to obtain reasonable life but to make working conditions tolerable around the carbonizer.

The two fans used in this plant, one

Diagram of heating gas flow and temperatures in typical Wisner carbonization plant





Expansion joint in stationary outer shell for 8 ft. carbonizers

handling gas at 800 deg. F. and the other at 600 had casings constructed of common steel with riveted steel wheels. Owing to the high operating temperature water-cooled bearings were used and the size of shaft in one fan was increased ½ in.

When the plant was dismantled after 18 months of operation, a negligible amount of oxidation of platework was revealed. In fact there was no discernible difference between steel of unknown analysis in fan casings, etc. and the firebox steel used in the principal equipment.

Using the experience gained in the pilot plant, a larger unit was designed with 6 ft. I.D. and a length of 84 ft. 6½ in.

In this larger unit, known as Unit 1, the annular space between inner and outer shells was 3⅝ in. The outer shell was 71 ft. 4 in. long supplemented with hoods and seals. Plate steel was open hearth flange quality (C, 0.20; Mn, 0.44; P, 0.016; S, 0.035, elastic limit 36,500, ultimate strength 58,000). Between inner and outer shells separators designed to permit differential expansion without strain were provided. These separators consisted of 4½ in. x 3½ in. x 15.7 lb. T's attached to outer shell and two 2½ x 2½ x 7/16 in. ells with upstanding legs on either side of web of *T* section. Suitable slotted holes were provided in tees and round holes in ells were fitted with bolts which were first pulled tight, then backed up 180 deg. and spot-welded, nut to bolt. Fifteen sets, 10 to a set, were furnished. Eight sets 9 in. long and 7 sets 12 in. long were placed at both ends of outer shell, at sides of tire plates and one under the drive sprocket. Sets 9 in. long were placed at 6 ft. intervals along the carbonizer.

The seal design adopted replaced former provision of asbestos cloth for longitudinal expansion with a rock wool packed gland. The depth of gland attached to non-rotating hood exceeded the sum of the depth of packing and estimated movement due to expansion. The rubbing surfaces of the seals were cast iron to steel. The rotating element was a heavy steel ell and the non-rotating part was cast iron. This cast iron was specified to contain a maximum of graphitic carbon in the belief that contact surfaces would speedily wear into a "seat" and wear would then cease. Three days of operations showed that wear did not cease, but cast iron was worn out.

The design adopted between tires and outer shell was that of external and internal gear. Sixteen internal teeth were cast integrally with tire, 6 in. long, 3½ in. wide and 1⅛ in. deep. External teeth were formed by welding 32 steel blocks 4 in. x 1½ in. x 20 in. to tire plate one block on each side of each tire tooth.

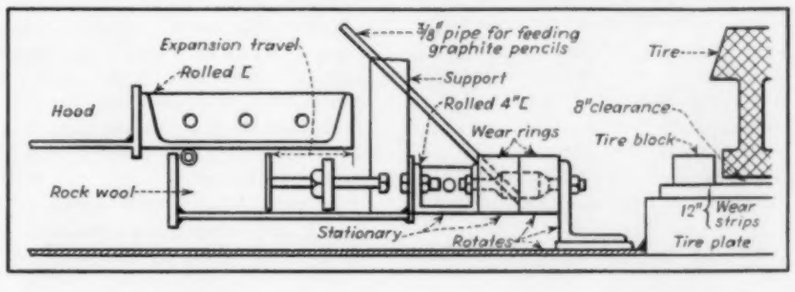
The drive sprocket was attached to the shell by flat bars at a tangent to the outer shell, welded thereto and bolted to beveled faces cast integrally with the sprocket. The sprocket was cast in two halves bolted together, facilitating assembly. The calculated expansion in diameter of the outer shell at the place where the sprocket was attached was ½ in. This would deflect each bar ¼ in. This design was successful and its use has been continued in subsequent designs.

This change in diameter in carbonizers and similar rotary machines must be considered in mounting all accessories. For example, seals centered and lined up perfectly cold will surely be out of center and perhaps even if lined up hot. The center line of a 6-ft. carbonizer is 7/16 in. higher at the hot end when it is hot and 7/16 in. higher at the cold end. The change in slope due to differences between these changes in elevation is not important, but the changes in elevation are and must be considered not only in design but in erection. It should be noted that increase in center line elevation is less than the radial expansion. This is because point of rolling support of carbonizer is above lowest point in carbonizer circumference. Not only does center line of the carbonizer vary in elevation with thermal changes, but during operation varies laterally with the power required to maintain rotation. Lateral difference in position of the carbonizer between rotating and non-rotating has been measured as being between 7/16 in. and ⅛ in. This movement varies with conditions of journals and surface of tires and trunnions as well as the weight of the material in the carbonizer. Movement of this order might not be noticed by operators of heat dryers, lime kilns, etc., but when seals are to hold a hot, combustible gas or 1,000 deg. flue gas under pressure, operators will speedily note any displacement.

The operation of No. 1 carbonizer in general was successful, although as a machine it was not as good as it might have been. The product was good. The seals wore out in three days and the method of seal support was faulty. Hood support (hung from overhead) was wrong. Ideas for improvement were abundant and many of them tried. Seals were repaired by replacing worn away cast iron with forged steel rings. For lubrication these rings were tapped for ⅜ in. pipe nipples for feeding graphite rods into rubbing contact surfaces by gravity. Later this lubrication was supplemented by insertion of graphite plugs over heads of each bolt used to attach wear rings, and this is now standard practice. Seal life is now satisfactory. Minimum seal life is 18 months to two years. Radial depth of wool packing was inadequate and still is. The deeper packing glands of later design give the longest life.

The mounting of the hood and its connection to the furnace on No. 1 was certainly unusual if not unique. The hood was supported by a four-wheel truck mounted on a pair of rails parallel to the axis of the carbonizer and

Details of 8 ft. carbonizer. Section through hot gas seal and tire connection, single shell carbonizer. Note deep boring of countersunk holes in wear rings for insertion of graphite plugs. All sections of seals in quadrants and spliced



placed above it. Movement of the truck along rails was in accordance with longitudinal expansion of the carbonizer and was caused by pressure between rotating and stationary surfaces of the seals. The rectangular connection of the hood to the furnace moved through a rectangular trough containing lead.

The lead bath was finally abandoned and the trough packed with rock wool, the hood anchored and supported underneath and the longitudinal expansion of the carbonizer taken care of by sliding of rock wool packing in the packing gland.

The original design of the connection of the tire to the carbonizer developed trouble after several operations. The external teeth were softer than teeth cast integrally with the tire. Deformation at contact points varied, lurching and bumping developed and some of the blocks broke loose. Operation would continue and at a convenient season replacements were made. These were probably made at a closer fit than the somewhat battered survivors and bumping and failure continued.

The outer shell and hoods of the 6-ft. carbonizer were insulated with rock wool mattresses 4 in. thick with chicken wire on one side and expanded metal on the outside, the individual mattresses being wired to their neighbors and the metal bands drawn snug and secured. The whole was covered with plastic insulating cement. This, while not entirely satisfactory, was an improvement over magnesia blocks. Based on experience under our operating conditions it is expected that rock wool mattresses will require replacement once in five years.

The trunnion bearings which were designed in accordance with practice in cement kiln design proved inadequate under the temperature conditions existing. One set of trunnion rolls were above the furnace and adjacent to the lead bath seal and one circular hot gas seal. In the summer of 1935 the original trunnions with bearings 5 in. x 6½ in. were removed and new ones with 7 in. x 9 in. bearings were installed. These new bearings were designed with oil wells in which were coils of copper tubing for water cooling. This is now standard practice. The total rotating weight including inner and outer shells, tires, sprockets, parts of seal and maximum anticipated live load is 84,195 lb. Normal operating rotating weight is 75,000 to 80,000 lb.

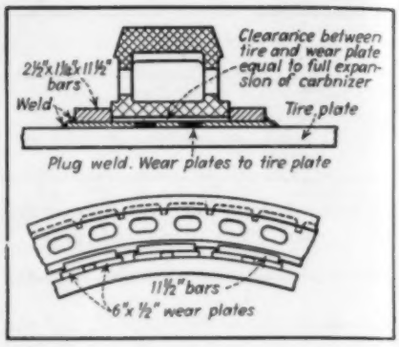
In this carbonizer the 2 in. outer shell, acting as a beam between trunnion rolls 54 ft. apart, supported the inner shell at intervals of 6 ft. or less. Separators were designed on the assumption that two diametrically opposite ones, out of each set of ten, must support the weight of the inner shell and its contents. No signs of deflection have been detected in either shell adjacent to separators. When new type separators were installed adjacent to hood at furnace a piece of the inner shell was removed for inspection. This plate had been at 930 deg. F. for several thousand hours, one side in contact with hot flue gas rich in oxygen and sulphur compounds, the other side in contact with carbon and carbon compounds. Mechanics reported that the carbon side was considerably harder than the other. Principal stresses in the outer shell were under 2,000 lb. per sq.in.

While operating experience was being acquired with No. 1 carbonizer a new and larger unit was being designed. In this unit, which was 8 ft. in diameter and 106 ft. 10 in. long, a different design of tire and tire attachment was used, but more important, the tires were placed at the end of the carbonizer, the heated portion of the carbonizer hung between tires and the outer shell stationary and entirely independent of carbonizer proper.

The revised design of tire is interesting. The tire is not attached to the carbonizer but merely restrained from moving along it by blocks welded to the end of the wear plates. The carbonizer turns freely inside the tire. The tire is driven by friction. This design is cheap and satisfactory.

The stationary outer shell is really a hood nearly as long as the carbonizer with furnace connection at one end and outlet connection at the other end. The inlet and outlet connections were fixed. The calculated expansion between these connections was 6 ft. This was provided for at 6 ft. intervals by slip joints. Thus small movements would occur at many places. The shell was not gas tight, particularly near furnace connection where expansion was largest and pressure highest. The sections were welded together and brackets or wheels attached. Since these changes have been made, operating difficulties arising out of expansion have been eliminated. The No. 3 carbonizer design follows that of No. 2, as modified, and its operation has been satisfactory.

A new kind of trouble developed in No. 2 carbonizer after some changes had been made in its discharge mechanism. This change caused the Disco (trade name of finished product) to be retained a longer time in the carbonizer. The depth of bed near the discharge was greatly increased which fact improved the product, but the resulting abrasion cut the carbonizer shell seriously. This was an entirely new experience. The inside of No. 1 carbonizer was always found covered with a layer of hard pitch or coke on shutting down. Thus, rolling of Disco was on a surface which was continually renewed by the process itself.


Clearance between tire and wear plate equal to full expansion of carbonizer
2½"x11½"x11½" bars
Weld
Tire plate
Plug weld. Wear plates to tire plate
11½" bars
6"x ½" wear plates

Detail of tire connection for 8 ft. carbonizer

The worn area was reinforced by lining with new curved plates welded inside the carbonizer. (Welding inside carbonizer must be preceded by very careful cleaning of surface. Chipping and grinding until metal is clean and bright is necessary to insure a good weld. All carbon must be removed.) The possibility of internal wear of carbonizer was studied and it was found that welding strips of steel parallel to the axis of the carbonizer would insure a deposit of hard pitch or coke sufficient to prevent internal wear.

Heating gas seal design was successful. Seals, similar in principle, were provided for by-product gas. In these seals movement from expansion is metal surface over rock wool packing, while rotation is taken by steel to steel contact. A new seal has been installed at feed end of No. 2 carbonizer combining these two motions on one surface. It would seem that constant turning of steel against rock wool would cause the destruction of the wool. Ordinarily that would be true but in this location, where movement from expansion is limited, any wear is immediately replaced by deposition of tar or pitch, so that contact surfaces speedily becoming pitch to pitch, one coating of pitch being on a resilient material.

Much more radical were the problems encountered in the metal under heat in the intermittent process. Here the job was to put heat through cast iron conductors into a stationary mass of coal. Using the Illingworth process, the test unit was a vertical retort 12 ft. high, 6 ft. long and 14 in. wide. The sides were steel heat boxes through which gas at 1,200 deg. F. was propelled at high speed.

The cast iron conductors or tapered I-beams as well as other castings were specified to be of the following analysis:

	Per Cent
Combined Carbon	0.5—0.68
Graphitic Carbon	2.6—3.0
Manganese	0.65—0.9
Silicon between	2 and 2.25
Sulphur less than	0.12
Phosphorus less than	0.6

Here the chief consideration was limiting growth anticipated from temperature variation. Some changes in dimension were provided for in design. Trouble from growth of castings did not interfere with operations which began in Fall of 1931 and were continued for a year or more. The conductors, about 12 ft. long, actually grew between ½ in. and ¾ in. The heating equipment consisted of a fan, a pair of "heat boxes" (between which conductors were grouped) and the necessary ducts between fan and the heat boxes.

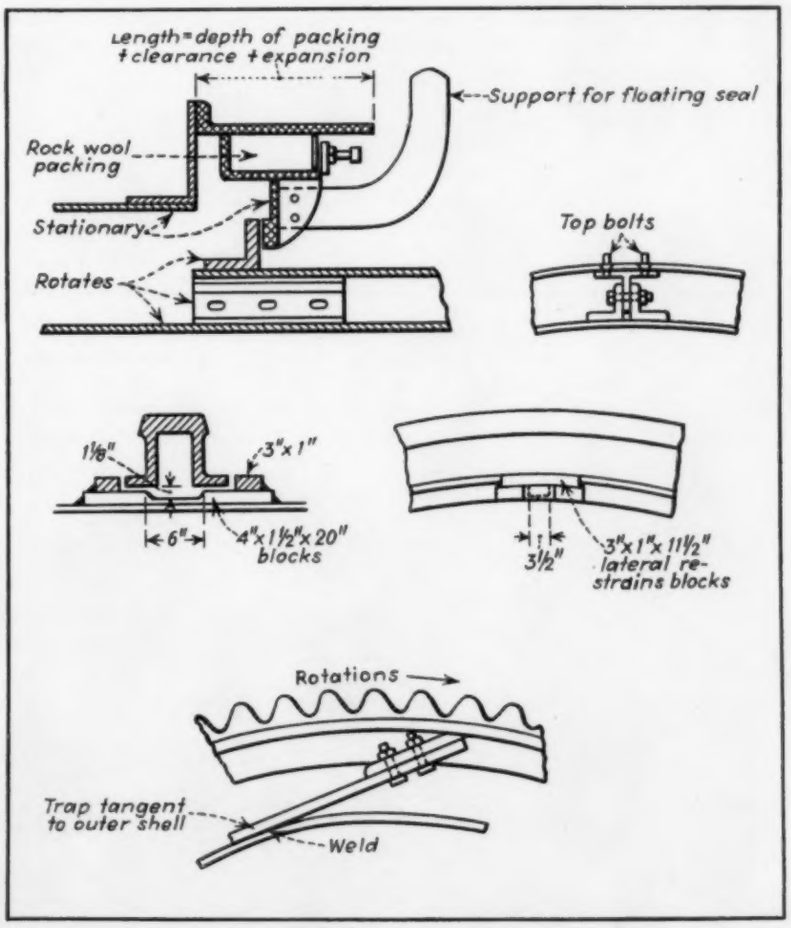
The fan was paddle wheel type, the blades of which were forged integrally with the shaft. Analysis of material used in construction was not divulged by manufacturer, but the fan was specified to handle flue gas 1,300 deg. F. at 1,150 r.p.m. The scroll case of fan was constructed of steel plates and angles of structural grade. The heat boxes and connecting ducts were of firebox steel of the following analysis:

C	Mn	P	S	El. in 8 in.	Red. in Area
0.14	0.42	0.018	0.0323	31.5%	61.3%
0.13	0.31	0.016	0.029	28.6	58.0
0.17	0.39	0.014	0.025	30	62

The heat boxes inclosing conductors were inclosed by brick walls. The walls were 25 in. thick and thus heat was given up by heat boxes on side of conductors at much higher rate than on side insulated by bricks. The differences in temperature arising from this circumstance resulted in considerable distortion in heat boxes. At end of each run temperatures of opposite side would become approximately equal, while shortly after beginning of each run considerable difference existed. Opposite sides were 2½ in. apart at bottom and 4¾ in. at top and connected to each other by splitters or separators welded to both sides. Therefore, temperature variations resulted in stress variations. Wherever these conditions existed warping, distortion and heavy scaling resulted. In the duct from heat box to fan inlet, where average metal temperature was as high if not higher than in heat boxes, distortion was not observed and scaling was negligible. The duct between fan discharge and heat boxes was lined with 4 in. sillimanite brick. On either side of duct about 2 ft. 6 in. from fan discharge was placed a natural gas burner. Between fan and burners a vent stack was provided. Fan and ducts not inclosed in brick work were insulated by two inches or more of insulating cement. The speed of flue gas through the system varied from 7,000 to 10,000 ft. per min. When operations ceased and the unit was dismantled the fan wheel was found in as good condition as when installed, fan casing showed, both internal and external rust, but nevertheless was in good condition. Combustion duct warped at connection to heat boxes (expansion joint), but generally was in fair condition and fan inlet duct was in good condition.

The chief lesson learned in this work is that ordinary steel and iron can be successfully fabricated to give continuous service under these moderate heat loads and that the best design is that which gets out of the way of the expansion. The objective here is to allow metal to expand and to calculate as closely as possible what it will do, and put in sliding or rolling joints and seals that will allow free play for the metal. So far as possible straight line expansion and relief of pressure due to expansion together with simplicity of equipment has resulted in a successful machine for the production of low-temperature coke.

Sketches of details of 6 ft. carbonizer. Top left shows section through seal. Top right shows separators between inner and outer shells. Center diagrams are of tire connection. Bottom shows design adopted for attaching drive sprocket



Panoramic view of the complete new refinery installation of the Richfield Oil Co. at Watson, Calif.

THE INSTALLATION at Richfield Oil Co.'s Watson, Calif., refinery represents one of the largest construction projects in the industry executed on a single contract,—approximately $5,000,000. The co-ordination of all phases of the construction was undertaken and completed by the C. F. Braun & Co., Alhambra.

The main plant is a double combination unit for combined topping and cracking,—two units operate in parallel. The total charge is 50,000 bbl. per day. The auxiliary units, installed concurrently, take care of debutanization, stabilization, hydrogen-sulphide removal, dehydration, depropanization, caustic wash, and catalytic polymerization. The new refinery water system cools and circulates 35,000,000 gal. per day.

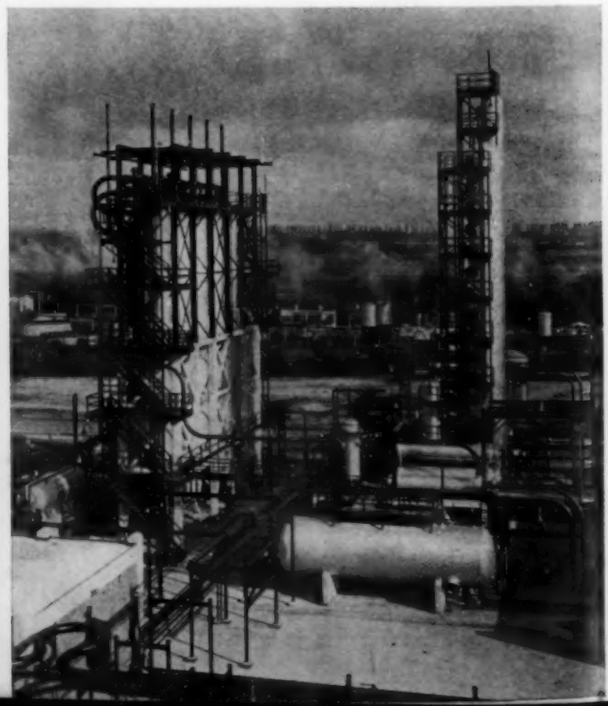
Contrary to the common practice of doing much of the work in the field, this plant was largely shop-fabricated. All of the major refining equipment was manufactured, and some 10,000 units of piping and accessories were fabricated and tested, and shipped to the site ready for field-assembly.

There are throughout the plant, 22 bubble-columns, and 110 heat-exchangers, condensers, and coolers. Sections of the cracking columns operating above 600 deg. F. are lined with 11 to 13 per cent chrome alloy, and are equipped with alloy bubble caps and trays. High-temperature exchangers are similarly protected and are equipped with alloy tube bundles. All of the columns, exchanger shells, and pressure vessels are stress relieved.

Process lines for temperatures of 600 deg. F. and higher were fabricated from alloy-steel, and were provided with vanstoned flanged joints so as to avoid, insofar as possible, the use of welding on the alloy-steel. These lines were made of very low carbon alloy steel (containing columbium) to reduce the possibility of air-hardening defects. Vanstoned joints of the globack-form, were used for services requiring Series 30 or higher pressures. All other process lines were of carbon-steel construction; cast-iron served only for low-pressure utilities.

The electrical power distribution

Left—Debutanizer-stabilizer and caustic wash units. Distillation area pump house, caustic reclaiming column, stabilizer, condensers, heat exchangers, debutanizer and feed surge drums. Right—Catalytic polymerization, depropanizer, and hydrogen sulphide removal units. Catalytic polymerization towers, surge drum, depropanizer column, hydrogen sulphide absorber behind it, loading racks and cooling towers in the background



Richfield's New Refinery

The main plant of the Richfield Oil Co.'s new refinery at Watson, Calif., is a double combination unit for combined topping and cracking, two units operate in parallel. The refinery was designed for handling a wide variety of California crude oils.

system is carried underground, both between the several units and within the units. Wiring for lights and instruments was run in conduits, mainly overhead, and supported on racks. The underground wiring is lead-covered cable, run in conduits which are encased in concrete.

The electrical installation includes some 40 miles of lead-covered cable and rubber-covered wiring, and over 16 miles of thermocouple wiring, all carried in galvanized conduit. In addition, many miles of instrument piping and conduits are routed throughout the units, in support racks. The instrument lines are located in a uniform and accessible pattern and are marked for the quick identification of any line. This has been invaluable.

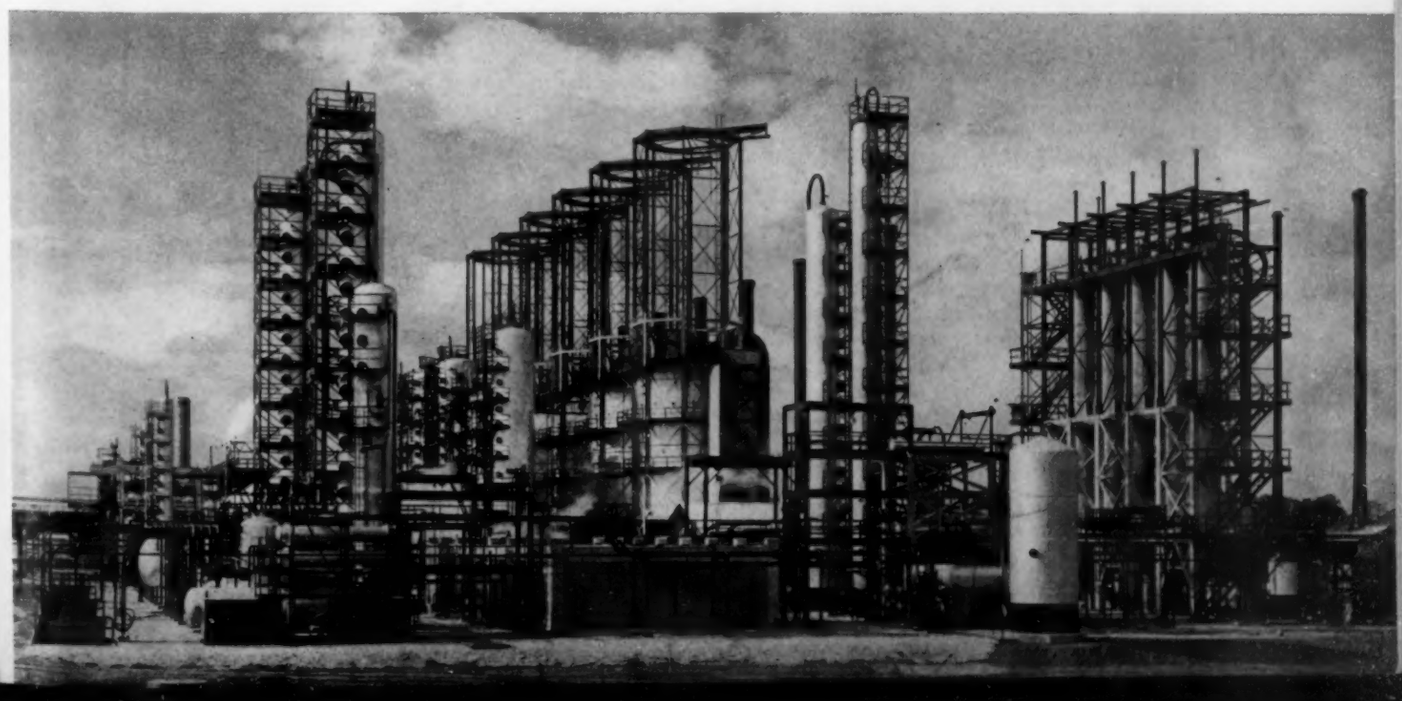
The six deFlorez vertical cracking furnaces have as heat-absorbing surface a total of some seven miles of alloy tubing.

The refinery water system, installed concurrently, is of mammouth proportions. It cools and circulates 24,000 g.p.m.—the equivalent of the requirements for a city of some 300,000 people. An existing cooling-tower was rebuilt, and a new cooling-tower installed. Four pumps handle the load, two pumps each driven by a 400 hp. motor circulate through the refinery, and two pumps each driven by a 250 hp. motor, lift from the hot-well over the towers.

The operations of the unit are controlled automatically. The most modern instruments for level, temperature, flow and other purposes have been installed. The control is from a centrally located room containing all of these instruments. It is readily accessible to all sections of the unit by interconnecting walks and stairways. The heater feed is governed by electrically operated motor valves, guided by indicating flow meters. A telephone system has been installed to give ready communication throughout the unit.

Capacity operation was attained within one week from the start of the initial runs. The only shutdowns were voluntary, for the purpose of inspection. There was not a single forced shutdown.

Distillation and polymerization area of refinery. From left to right: Caustic wash unit, stabilizer and debutanizer in back; distillation area pump house; hydrogen sulphide removal and depropanizer units; catalytic polymerization unit. The six de Florez heaters for the double combination unit are in the background. Notice the concrete covering on the lower sections of the steel columns



MR. KIMBALL'S article is one of the series on Process Equipment Design which was introduced in our May, 1939, issue

Shelter for Chemical Processes

BY P. B. KIMBALL, chief engineer of Rumford Chemical Works, Rumford, R. I. *Despite his electrical engineering degree from M.I.T., Mr. Kimball's professional life has been spent largely in chemical engineering activities such as design, estimating and development in the dyestuff, crude drug and heavy chemical industries.*

DESIGN FOR OPERATION

HOUSING is a problem for the chemical engineer, as well as for the F.H.A. Mortals have been interested in shelter at least since the cave man, and shelter, like clothing, having to be designed to suit the necessity, has received much consideration—from fig leaves to Chic Sales. Unfortunately, industrial buildings have not often enough been designed for decorative purposes, and since secrecy of processes usually forbids the entertaining of visitors in chemical plants, architectural beauty is not given much consideration (except in food products plants where the advertising value seems to justify the additional cost).

In the design of buildings for housing chemical processes, there are few, if any, general rules to guide the engineer, owing to the endless variety of equipment arrangements encountered. Anyone with a large engineering staff can determine quite accurately the most economical building to fit a certain process by making a hundred layouts and sixty odd estimates. Experience, however, is a valuable asset. Experience and sound judgment make it possible for an engineer to visualize different designs and to select, apparently instinctively, the type which is best suited and most economical in a given situation. An engineer may "play a hunch," but this is merely the subconscious functioning of judgment gained from experience. It is simply the extension of successful ideas used in previous accomplishments—and the avoidance of previous mistakes. One cannot be robbed of it, or impart it entirely to others. Nevertheless, some suggestions may be helpful.

In considering the design of buildings, we may leave in the background that plague of the chemical plant designer—trying to fit a complicated process into an old building. We will assume that "the buck has been passed" to us—that the process designer has laid out the process and has told us to "wrap the building around it".

Is Housing Required?

One of the first questions to be answered is "How much of the process must be housed?" The oil industry has demonstrated that much equipment does not require shelter. Modern sulphuric acid plants leave several items of apparatus exposed to weather without detriment to apparatus or process. Developments in remote control make it possible to have out in the open much equipment formerly housed.

Distilleries, however, using apparatus somewhat similar to that used in petroleum refining (from the standpoint of unit operations), keep the apparatus well housed. This is probably due in part to tradition dating from an edict of Henry VIII, requiring that the manufacture of alcoholic liquors be confined within buildings with doors and windows heavily barred to prevent theft to evade taxes. Tradition has also been influential in perpetuating the manufacture within buildings of all goods intended for human consumption. Furthermore, batch operations requiring frequent sampling and testing and close temperature regulation are more easily controlled indoors. There is a definite trend, however, toward locating process apparatus outdoors wherever possible.

In general, it may be said that continuous process operation lends itself more readily to remote control than batch operation, hence continuous process apparatus may more conveniently be located out of doors. Incidentally, since continuous process equipment is smaller per unit of product than batch process equipment, the former has the advantage of requiring less floor space in a building. Equipment requiring constant attention should be housed to protect the operators from severe weather; but even this condition may warrant further consideration of the process designer to determine whether improvement in his design may not be possible. A single group of apparatus or section of a process may require certain constant conditions of temperature or humidity. In such a case an air conditioned building (or section of a building) may be desirable.

The location of the building may be determined by any one or more of a variety of factors, such as natural terrain and soil conditions, access to railroad siding, cooling water supply, dependent processes, etc.

In the chemical industry perhaps nothing is so constant as change, and probable obsolescence often makes it necessary to consider a new plant as a temporary unit only. Hence light, inexpensive construction is frequently indicated.

A so-called "functional building" may be built exactly to suit the process. Or if the nature of the process demands heavy construction with consequent large investment, general design and main framing should be of standard construction and any odd framing required for special equipment should be designed to be easily removed, so that radical changes in process or an entirely different process may be accommodated in the building.

One of the trends in modern building design is toward better working conditions, including heating, lighting, and sanitary services in line with the modern ideas of more decent treatment of workers as human beings. Radical departure from standard design may be required because of necessity for ventilation to prevent concentration of explosive fumes, harmful dusts, excessively humid or poisonous atmosphere, etc.

The design may also be limited in the choice of materials of construction due to the corrosive nature of fumes, such as hydrochloric acid, or liquors that may boil over, such as phosphoric acid.

The development of the very efficient unit heaters makes possible much wider use of "tin buildings" where there is promise of high return on investment for but a few years. Where longer life of the operation is assured, or where simple design and standard construction of the building are possible, corrugated asbestos is an ideal material for chemical plants, on account of its resistance to corrosion and its lower thermal conductivity, resulting in somewhat lower building heating cost. It also can be relocated if it should become necessary to add another bay at some future date.

Single or Multi-Story?

Single-story buildings are ordinarily much less expensive than multi-story buildings per unit of floor area (except where the price of land is very high). Rough sketches should suffice to determine whether additional elevating and pumping equipment offset the higher cost of multi-story buildings.

Heavy loads on the ground floor on concrete foundations with or without piling will usually be independent of building foundations. Heavy loads above the ground floor may call for independent column supports or, if all the apparatus is uniformly heavy, the floor would be designed for uniform high loading capacity with the lighter floor framing members spaced to suit apparatus base plates, etc. Light loads—for example small tanks—may be carried on platforms or suspended from above. Truss loads should usually be restricted to pipe lines, although conveyors, and occasionally runways for light buggies, may be hung from trusses. Where apparatus is heavy, columns should be designed to carry traveling crane runways.

Specific examples illustrating the wide differences in types of construction are noticeable everywhere. Food products which may be considered as on one of the outer fringes of the chemical industry may be manufactured in multi-story buildings of steel and glass blocks with concrete, tile or maple flooring. A sulphuric acid plant building may be of steel with corrugated iron, protected metal, or asbestos siding and roofing, and it would ordinarily be a relatively high single-story building. An ore crushing and concentrating plant located

Rumford Chemical Works, Rumford, R. I., with new sodium tetraphosphate building beyond the water tank

near a mine may provide interesting possibilities for the building designer. If the mine shaft emerges sufficiently high on a hillside, the building could be a series of single-story sheds, ordinarily of wood, each succeeding shed at a lower elevation, so that the material would flow by gravity through the process to a railroad siding below. Such a design would entail heavy timber bin supports or a large amount of excavation, or both. In the absence of suitable terrain, however, the plant would be essentially a high steel structure designed to support heavy bins, with screening and concentrating equipment, together with operating platforms, supported in between the different bin levels. Housing would be simply a corrugated iron enclosure merely incidental in relation to the design of the structure itself, but wind loads would require careful design of foundations to prevent overturn of the structure.

Interesting problems may confront the building designer in certain highly specialized chemical plants, e.g., one wherein crude drugs are extracted from herbs, roots, barks, etc. In such a case raw materials may be measured in tons and finished products in fluid ounces. In this instance, especially, close coordination between process and building designers is essential to obtain lowest overall cost of product.

A typical example of the "functional building" is the new sodium tetraphosphate plant at Rumford. This building consists of four separate sections: the first, of three stories; the second, of one; the third, of two; and the fourth of one. In the first section dry solid raw material is received on the ground floor, elevated to the third floor and fed into a mixing tank. Liquid raw material is also received and stored on the first floor and pumped as required to the third floor mixing tank. The mixing tank, while supported by the third floor framing, projects through and below it. The solution flows by gravity to aging tanks on the ground floor and is pumped back to feed tanks on the second floor from which it flows by gravity to furnaces in the second section of the building, which has only the one floor. The solid product of the furnaces is cooled in long conveyors to intermediate storage, milling, and screening operations in the third section of the building. Coarse material is stored in a large bin supported by the second floor framing and projecting through and below it, and is elevated to the crusher on the second floor, which feeds the screen located below the second floor, directly beneath the crusher. The finished product is barreled directly from the screen. The fourth section of the building is simply a one-story section for storage of barreled product and for shipping.

One of the interesting phases of building construction—which provides a sort of occasional holiday job for the engineer—is also encountered at Rumford in the restoration of the first Rumford Chemical Works building to its original design and condition. This building, now 85 years old, was used originally as a combined office, laboratory, and factory in which hydrochloric, nitric, and phosphoric acids were manufactured, and soon afterwards tin crystals, copper sulphate, mono-calcium phosphate, and Horsford's Yeast Powder (the original term for baking powder). Some time later, and continuing until about 30 years ago, this building also included a boiler room. Since that time, the building has been used for the manufacture of calcium sulphide and tri-calcium phosphate, and more recently for housing pilot plant operations and a truck repair shop. The restoration of this building, which will be used as a museum to house an exhibit of early equipment used in plant and laboratory, is being made ready for the celebration of the eightieth anniversary of the company in the successful manufacture of an all-phosphate baking powder. This restoration involves delving into architectural design and timber construction of nearly a century ago. The present sound condition of most of the timbers in this building shows that the advantages of wood construction for chemical manufacturing buildings should not be overlooked.

Designing buildings for chemical plants is an interesting pastime for the reason that there is nothing cut-and-dried about it. It is not simple routine work. Each case presents new problems. Changes in process may make the design of a building for a process new two years ago entirely obsolete today. *There is no formula.* The simplest construction—even the most obvious—is often the best. Common sense and sound judgment must be combined with ingenuity, that practical necessity in all engineering for overcoming obstacles and solving problems. The possession of these handy tools, incidentally is not entirely limited to old men or to college graduates—a child may learn quite early to trace cause from effect and to observe the effects of causes (also to develop some ingenuity in overcoming obstacles)—hence, perhaps, the expression "engineers are born—not made." But experience in designing "a building to suit the process" is still a valuable asset.

Typical of the functional type of building is the new sodium tetraphosphate plant recently completed by the Rumford Chemical Works

MR. BROWN'S article is one of the series on Process Equipment Design which was introduced in our May, 1939, issue.

High Pressure Vessel Design

BY CHARLES O. BROWN, consulting chemical engineer, New York, and specialist on high pressure industries and alkalis. *This is the second of two articles by this author on storage and reaction vessels. The first, in our May issue, dealt with low pressure equipment. The present article takes up design for higher pressures.*

DESIGN FOR OPERATION

AS WAS POINTED OUT in the first article of this series (*Chem. & Met.*, May 1939, pp. 310-13) there is no definite boundary line between high and low pressure process equipment, since what is high pressure for one industry may be considered low or moderate pressure in another. One basis for the division is the type of formula that is required for determining the necessary wall thickness. For lower pressure equipment having comparatively thin walls, the assumption is justifiable that the stresses are uniformly distributed throughout the thickness of the wall material. On this account, the use of simple stress formulas is permissible. With the thicker wall needed for higher pressures, however, the stresses become non-uniform across the wall and a proper representation of the facts requires more complex formulas. When dealing with thick-walled vessels, therefore, having a wall thickness more than 5 to 10 per cent of the diameter, we may consider that we are working in the high pressure region.

The writer feels that a treatment of pressure equipment at the present time may be confined to welded and forged vessels, omitting riveted vessels. Pressures as high as 300-500 lb. per sq.in. are now called modest and at the present time it is believed that riveted vessels for even 300 lb. pressure are too costly for use, giving consideration to several other disadvantages. On the basis that pressure vessels are largely welded, or made from forgings, it is quite obvious that the design of the vessel is governed quite as much by the requirements of economical fabrication as by the analysis of the stresses and strains in an ideal design. This is especially true in the case of forgings. Most forgings require a vessel to be unusually long, but of small diameter. In some cases, for example in catalyst vessels, the shape factor of the small diameter cylinder has little to recommend it. This situation has done much to develop the use and improvement of welded steel vessels for high pressures. In a comprehensive analysis the welding art has progressed so splendidly that at the present time the difference between a modern welded vessel for high pressures and a vessel made from a forging is very slight, and is growing less.

Vessels for high pressures must be of heavy massive construction, so massive, in fact, that the weight of material very much influences the shape and size of the vessel and the design. Unlike the simple vessels described in the previous article, space per cubic foot within a high-pressure vessel, whether of forged or of welded construction, becomes extremely valuable and extraordinarily thrifty use must be made of such space.

In designing a pressure vessel of the welded type, as in the case of simple tanks, the shape factor is of great importance. Since the design of the shell proper is relatively simple compared to its complicated ends, with their gaskets and closing devices, and since wall thickness increases very rapidly with increasing diameter, the shell is usually made as long as is convenient, and if possible, one end is made by forging, or "necking down" the shell. This results in an open pressure vessel without seams, in the case of a forged vessel, or only two welded seams for a welded vessel. This construction is cheap and practical for welding up to a thickness of metal representing the maximum which can be rolled into a tube of the desired diameter. Obviously, a forging made from a solid billet is not so limited.

A word about the art of forging may aid the designer of high pressure vessels. "Forging" is usually employed for large high-pressure vessels, weighing from 10 to 100 tons and working at 100 to 1,000 atmospheres per sq.in. pressure. Smaller vessels (so called cylinders) are deformed circular disks made by spinning a steel disk around a mandrel, the center of the disk becoming the bottom of the cylinder. The forging process starts with a cast billet or ingot of the steel alloy desired. This is heated to a high temperature and then pierced with a die, making a hole from end to end. Then the pierced billet is heated and pressed on a water cooled mandrel in a powerful press, increasing the diameter of the hole and the length of the cylinder until both inside and outside diameters and the length of the forging are sufficient to produce the desired vessel after machining away the excess metal. It is plain that this operation does not permit economical production of extreme shapes and irregularities in high pressure forgings.

The stress analysis required to fix the design of a high pressure vessel

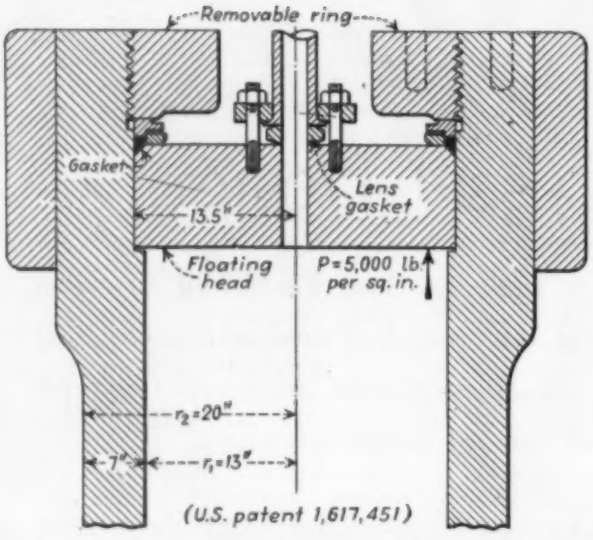


Fig. 1—Self-sealing floating head with thrust taken by a threaded, removable ring

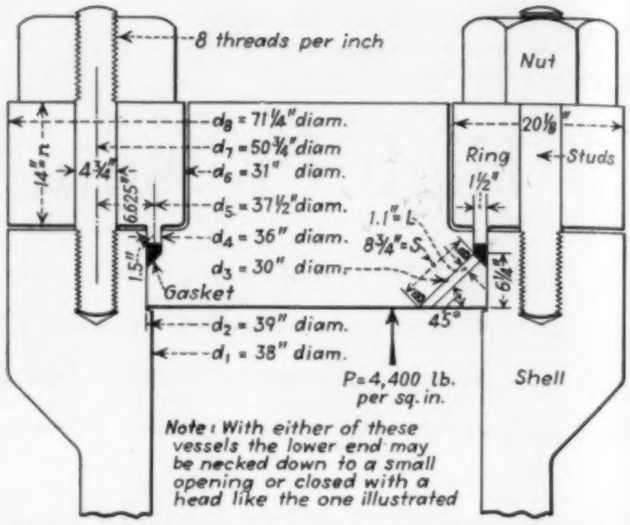


Fig. 2—Self-sealing floating head using studs and nuts instead of a threaded ring

includes calculation of the tangential (circumferential or hoop) tension in the shell; the radial compression; and the axial or longitudinal tensile stress. The formulas for determining wall thickness of thick-walled cylindrical vessels have been devised by Lamé, Clavarino and Bach. The results of these formulas do not vary widely, as is clear from curves representing each formula which were published by Norman Krase (*Chem. & Met.*, Sept. 1930, p. 540ff.).

Vessel Calculations

To clarify the application of the Lamé formula to the stress analysis of a high-pressure vessel, a sketch of a forged catalyst chamber closed with a floating head is shown in Fig. 1 (U.S. Pat. 1,617,451). The details of this closure are not of special importance and there are many other designs of a similar type. However, this one will serve to illustrate the method of computation.

The hoop or circumferential stress s' for the vessel of Fig. 1 is given by Lamé as

$$s' = P(r_2^2 + r_1^2) / (r_2^2 - r_1^2) \qquad (1)$$

where s' and P (the latter the working pressure) are in lb. per sq.in.; and r_1 and r_2, the inside and outside radii, are respectively 13 and 20 in. For 5,000 lb. working pressure $s' = 5{,}000\ (20^2 + 13^2)/(20^2 - 13^2) = 12{,}300$ lb. per sq.in. The compression pressure on the inside surface is the working pressure, 5,000 lb. per sq.in., and on the outside surface, zero. The longitudinal stress in the shell, parallel to the axis, is given by a modification of the simple longitudinal stress formula (see equation 2, first article):

$$s'' = Pr_1^2/(r_2^2 - r_1^2) \qquad (2)$$

and is $5{,}000 \times 169/231 = 3{,}660$ lb. per sq.in. The circumferential stress s''' for the outside surface of the cylinder is given by the well known equation

$$s''' = 2\,Pr_1^2/(r_2^2 - r_1^2) \qquad (3)$$

and is $5{,}000 \times 338/231 = 7{,}320$ lb. per sq.in. These calculations, completely defining the conditions of the cylinder, show that the stresses are greatest at the inside surface, least at the outside surface, but conservative in any event. Normally shear stresses need not be considered.

When the temperature inside the cylinder is higher than outside, additional stresses are developed in the shell which are not as great as might be anticipated. The effect is to reduce the inner stress and increase the outer. Assuming a constant heat flow from temperature T_1 inside to temperature T_2 outside the cylinder, the resulting stresses can be found from the following privately developed formula:

$$s_T = \frac{mE\epsilon}{2(m-1)}\,(T_2 - T_1)\left(\frac{2r_2^2}{r_2^2 - r_1^2} + \frac{1}{\ln \frac{r_1}{r_2}}\right) \qquad (4)$$

where s_T = the added stress (either positive or negative) due to temperature difference; m = 1/Poisson's ratio = 4; E = the modulus of elasticity = 29,000,000 lb. per sq.in.; ϵ = coefficient of thermal expansion* per deg. C. = 0.00001167; and ln is the natural logarithm to the base e. Then $s_T = 4 \times 29{,}000{,}000 \times 0.00001167\ (800/231 - 2.32)/2 \times 3 = 257$ lb. per sq.in. for each degree C. temperature difference. For 5,000 lb. working pressure the inner circumferential stress is 12,300 lb. $- (T_1 - T_2) \times 257$ lb. per sq.in.

A similar calculation is then made to determine the effect of temperature on the outside stress. Equation (4) is again used, with the modification that the last term is $(2r_1^2/r_2^2 - r_1^2 + 1/\ln r_1/r_2)$. In this case $s_T = -194$ lb. per sq.in. per degree C. temperature difference and the outer circumferential stress is $7{,}320 + (T_1 - T_2) \times 194$. The maximum shear stress permitted for the alloy used, as determined by these calculations, will govern the design of the cylinder. Inspection of the formulas will show that for small temperature differences the inner stress will control, while for larger temperature differences the outer surface stresses govern the design.

The fundamentals behind the de-

* See Harold Tongue, "Construction and Design of High Pressure Chemical Plant," D. Van Nostrand & Co., 1934, p. 260. This author gives a good tabulation of the variation with temperature of the coefficient of expansion of various types of steels.

sign of the type of head shown in Fig. 1 are easily understood. Professor Bridgman of Harvard was perhaps the first to use this simple principle, and the additional details shown in Fig. 1 are largely for the purpose of making the structure economical, and providing for practical plant methods for opening and closing the head during operation. In some cases it is desirable to modify the thread in the removable ring to a buttress type which permits the ring to be removed by turning through one-eighth revolution. The gasket is confined by two separate rings. This design was used in the early days of high pressure development, and was intended to overcome any difficulty in removing the gasket due to the steel parts confining the gasket upsetting and biting into the forging itself. If this defect occurred these two light rings were simply cut out in pieces and then the gasket removed and the rings replaced with new ones when the vessel was next closed. Only a small initial gasket pressure is developed by the heavy removable ring, after which the vessel is internally loaded with the working pressure and the head moves upward, finding itself a seat due to the flow of the gasket until the permissible gasket space is completely filled. This type of joint is well adapted to vessels whose operation requires frequent wide variation in pressure.

Head Without Threaded Ring

As mentioned above there are other designs than the one indicated in Fig. 1 for effecting a closure of high pressure vessels by means of the "floating head" principle. One which does not use the heavy threads on the forging itself and hence does not require a carefully threaded ring, is shown in Fig. 2. This design is somewhat cheaper than the one of Fig. 1, and the weight of the metal in the large forging is a little less for a given inside capacity of the same diameter. The important stresses in the separate details of this closure may be computed as follows: The material used is an alloy steel of 1 per cent Cr, 0.2 per cent Va, 0.3 per cent C, and traces of P and S. Its elastic limit is 85,000 lb. per sq.in. The dimensions shown in the sketch are without the necessary tolerances, but will serve to illustrate the method of calculation. The working pressure is 4,400 lb. per sq.in.; the test pressure (water) is 6,600 lb. per sq.in.; and the temperature of the shell, 140 deg. C. In this design the load on the head due to the internal pressure is absorbed by the reaction of the gasket. The ratio of total pressure to gasket pressure is $(39^2 \times 0.7854)/(39^2 \times 0.7854 - 36^2 \times 0.7854) = 6.76$.

The working bearing load on the four surfaces confining the gasket is $6.76 \times 4{,}400 = 29{,}600$ lb. per sq.in., since the gasket will "flow" under the conditions of operation. The test bearing pressure is 1½ times this, or 44,500 lb. per sq.in. These values are permissible for the steel selected and indicate that the gasket area is close to the optimum. The working load against the head at the working pressure is $\pi r^2 P = 0.7954 \times 39^2 \times 4{,}400 = 5{,}260{,}000$ lb. total. Since this pressure is all taken through the gasket to the stud bolts, the tensile stress in the bolts must be calculated. A ring of the size indicated will accommodate 15 or 16 bolts of 4¾-in. diameter and still leave room for the massive end wrench needed to tighten the nuts. The number and size of the bolts may be selected by a study of several combinations. For a start assume 15 bolts of 4¾-in. diameter with eight threads to the inch (a thread pitch which has proved practical in this type of work). For such a bolt the diameter at the root of the threads is 4.587 in. Hence the area of metal in 15 studs is $15 \times 4.587^2 \times 0.7854 = 246.1$ sq.in. The working stress at the root of the threads is then $5{,}260{,}000/246.1 = 21{,}400$ lb. per sq.in. During the test this stress rises to 32,100 lb. per sq.in., which is a safe stress for a high tensile alloy steel under atmospheric temperature and a test period of a few hours, too short for creep effect to become evident.

The bolt ring can be considered as beam of net width equal to ring width minus bolt diameter, and the working tangential stress in the ring can be determined from the moment produced by the working load applied upward on the center of the gasket confining ring ($d_5 = 37.5$ in. diam.) and the bolt reaction applied downward ($d_7 = 50.75$ in. diam.). The moment arm therefore is 6.625 in. The equation for the ring stress is

$$s_r = \frac{mPA \times 6.625}{\pi\,(0.5d_5 - 0.5d_6 - 4.75)\,n^2} \quad (5)$$

where $m = 1/\text{Poisson's ratio} = 4$; P = working pressure, 4,400 lb. per sq.in.; A is the head area $= \pi\ 39^2/4$ sq.in.; 6.625 is the moment arm (see Fig. 2); d_5 and d_6 are diameters shown on Fig. 2, inches; and n is the ring thickness, 14 in. Then $s_r = 4 \times 5{,}260{,}000 \times 6.625/3.1416 \times 15.375 \times 14^2 = 14{,}700$ lb. per sq.in. At the test pressure the stress is $1.5 \times 14{,}700 = 22{,}000$ lb. per sq.in.

The head design presents few other problems except an analysis of the bending and shear stresses around the gasket area. Since the thickness of the head below the gasket means a corresponding increase in shell length at its thickest section, this dimension should be kept as small as possible. In Fig. 2 this thickness is taken as 6.25 in. for illustrative purposes. In the section B-B of the drawing the working bending stress is given by the equation*

$$s_b = 6\,PAL \text{ cosecant } 45 \text{ deg.}/\pi d_5 S^2 \quad (6)$$

where L, S and d_5 are dimensions given in Fig. 2. Then $s_b = 6 \times 5{,}260{,}000 \times 1.1 \times 1.4142/3.1416 \times 30 \times 8.75^2 = 6{,}750$ lb. per sq.in. The working shearing stress in section B–B is $5{,}260{,}000 \times 1.4142/3.1416 \times 30 \times 8.75 = 9{,}050$ lb. per sq.in. At the working pressure the combined bending and shearing stress is given by the square root of the sum of the squares of the two stresses or $(6{,}750^2 + 9{,}050^2)^{\frac{1}{2}} = 11{,}270$ lb. During test at 1½ times the working pressure the combined stress would be 16,905 lb. These values are all permissible for the steel selected and, in fact, possibly too conservative; however, working close to the ultimate strength should be done cautiously. To do so requires great judgment based on experience.

Metal provided to allow for corrosion should be added to the design as calculated, based on test and experience. If liners are to be used to lessen the cost of corrosion, no advantage should be taken of the strength so added, for if properly used, the strength of the liner will not be available when the corrosion has done its work.

The work of the designer must conform closely to those codes which are recognized legally in the locality in which the design is to be used. It should be noted that the API-ASME Code is not accepted in some states, although generally it is more conservative than the ASME Code.

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* This equation is derived by considering the cover as a circular beam loaded normal to the 45-deg. gasket face. Then bending stress = bending moment ÷ section modulus. The section of the beam is $8.75 \times 30\pi$ in.^{2} and the section modulus $(8.75)^2\ 30\ \pi/6$ in.^{3} The bending stress is the total load × moment arm.

Thermal Conductivity of Liquids

Until recently few data on the thermal conductivity of liquids at varying temperatures have been known accurately. Data that have appeared in the last few years have not been presented in the most convenient fashion. Mr. Davis has fitted new equations to these data and has constructed nomographs for covering a considerable temperature range for each of the systems water-methanol, water-ethanol and water-glycerol.

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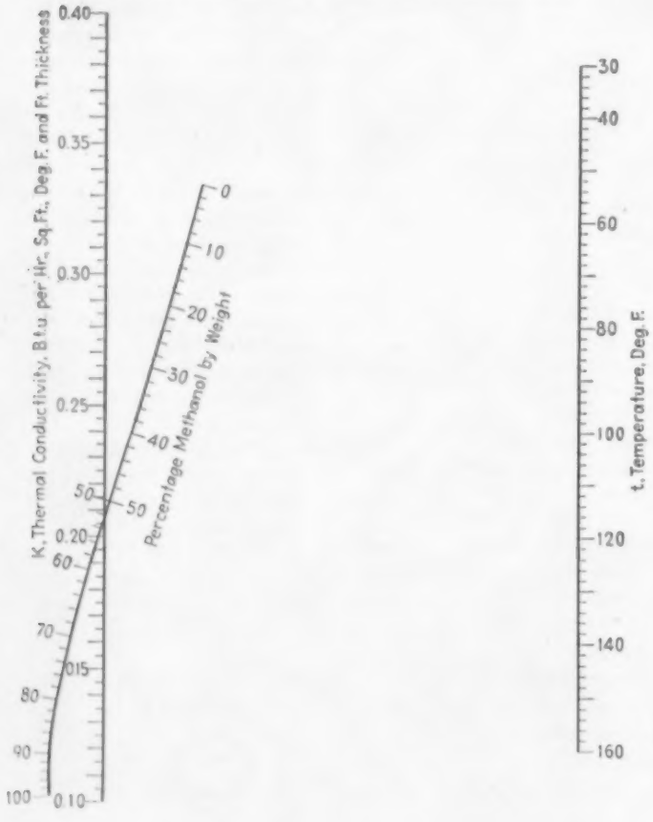
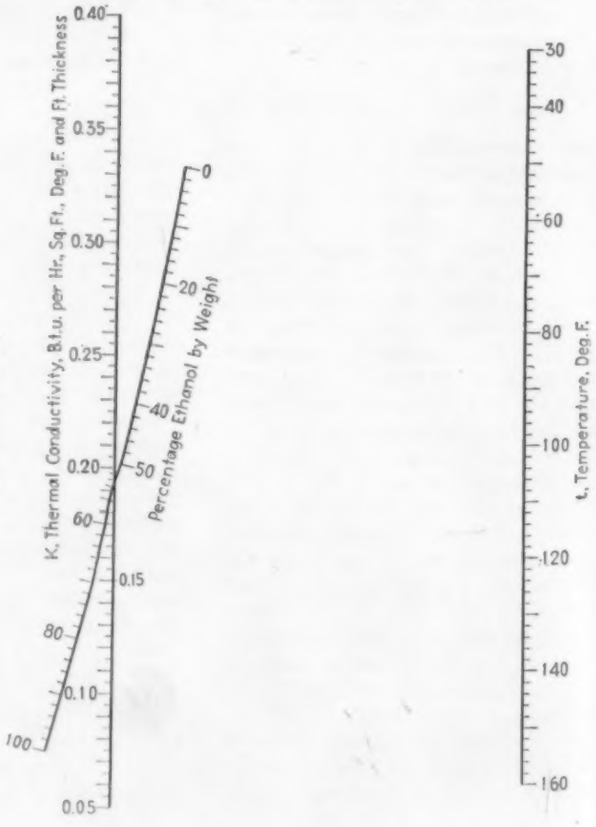
IN THEIR "Elements of Chemical Engineering" (McGraw-Hill Book Co., New York, 1936) Badger and McCabe state that "the temperature coefficients of thermal conductivity are known with accuracy only for water among the liquids." Excellent data are now beginning to appear and we are indebted to Bates (*Ind. Eng. Chem.*, **25**, 1933, p. 431) for a complete investigation of the thermal conductivities of aqueous glycerol solutions between temperatures of 10 and 80 deg. C., and to Bates, Hazzard, and Palmer (*Ind. Eng. Chem., Anal. Ed.*, **10**, 1938, p. 314) for similar data covering aqueous methanol and ethanol solutions between 10 and 60 deg. C.

The data are presented in tabular form and as plots of conductivity against temperature for constant composition and as isotherms on conductivity-concentration plots. Conductivity values are given in gram calorie-

Thermal conductivity of methanol-water mixtures



Thermal conductivity of ethanol-water mixtures



centimeters per second per square centimeter per degree Centigrade. In view of the importance of the data it appears worthwhile to effect a more convenient nomographic presentation yielding conductivities in English engineering units, namely, B.t.u. per hour, square foot, degree F., and foot of thickness.

Hyperbolic Sine Equation

Bates, Hazzard, and Palmer quote the Barratt-Nettleton equation ("International Critical Tables," Vol. 5, p. 227, McGraw-Hill Book Co., New York, 1929) for calculating the thermal conductivity of binary liquid mixtures when the conductivities of the two liquids are known:

$$K \sinh (100\mu) = K_1 \sinh (p_1\mu) + K_2 \sinh (p_2\mu)$$

where p_1 and p_2 are the percentages by weight of the two constituents and μ is a constant specific to the constituents and independent of temperature in the ranges encountered in the investigation.

Although this is an extremely simple equation, considering the nature of the data, it requires a knowledge of the conductivities of the pure components at the temperature in question and is thus not well adapted to nomographic presentation. For this reason and in the interests of greater precision new equations correlating the data have been developed. The thermal conductivity, K, in B.t.u. per hour, square foot, deg. F. and foot thickness is related to the Fahrenheit temperature t, by the expression

$$K = a + b\,t$$

Tabulation of "a" and "b" Values in Terms of "c"

Methanol:

$$a = 0.3076 - 0.002391\,c + [3.008\,c^{1.703} - 0.02204\,(c-40)^{2.542}]\,10^{-6}$$

$$b = [51{,}130 - 992.2\,c + 0.689\,(c-40)^{2.542}]\,10^{-6}$$

Ethanol:

$c < 62.5$

$$a = 0.3081 - 0.002612\,c + 0.636\,c^{2.058}\,10^{-5}$$

$$b = (49{,}700 - 908\,c)\,10^{-6}$$

$c > 62.5$

$$a = 0.3116 - 0.002668\,c + 0.636\,c^{2.058}\,10^{-5}$$

$$b = (38{,}810 - 732\,c)\,10^{-6}$$

Glycerol:

$$a = 0.3082 - 0.001736\,c + 0.00760\,c^{2.815}\,10^{-5}$$

$$b = [49{,}330 - 623.2\,c + \frac{3{,}495}{e^{3.55-0.14c} + e^{0.14c-3.55}} + 614\,(c-67)^{1.824}]\,10^{-6}$$

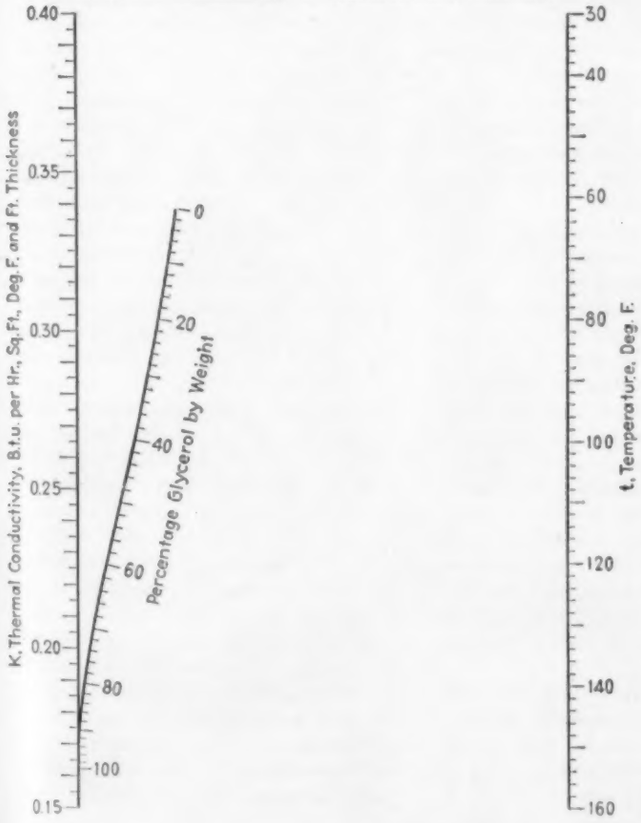
where, for the various binary mixtures, a and b are defined in terms of c, the percentage by weight of the solute, as given in the tabulation at the left.

The accompanying nomographic charts, constructed from these equations, afford a rapid and accurate means of calculating the thermal conductivity in terms of the concentration of the solute and the temperature since a straight line will cut the three scales in values physically consistent. It will be noted that for certain concentrations thermal conductivities are independent of temperature, i.e., 52 per cent methanol, 53 per cent ethanol, and 93 per cent glycerol.

Accuracy of Equations

The table compares the accuracy of the Barratt-Nettleton equation with the present expressions by listing the percentage deviations of the calculated values from the observed values over representative concentration and temperature ranges. The new equations deviate by an average of 0.6 per cent from the observed values as against an average deviation of 1.75 per cent for the hyperbolic sine equation.

Thermal conductivity of glycerol-water mixtures



Comparative Accuracy of Hyperbolic Sine Equation and New Expressions

System	Temp., Deg. F.	Percentage Solute by Weight	Percentage Deviation of Calculated From Observed Values: B – N Eq.*	Present Equations
Water-Methanol	50	20	0.2	−0.8
		40	0.7	−0.8
		60	0.4	−0.8
		80	0.3	0.3
	86	20	0.3	−0.5
		40	−1.0	−1.5
		60	−1.8	−0.9
		80	−2.6	−0.3
	122	20	0.6	−0.2
		40	−1.7	−1.2
		60	−4.4	−1.0
		80	−4.3	0.8
Water-Ethanol	50	20	0.2	−0.5
		40	0.1	−0.2
		60	−1.5	−0.8
		80	−1.7	−0.3
	86	20	1.4	0.8
		40	−1.2	−1.3
		60	−2.6	−1.3
		80	−2.5	−0.5
	140	20	1.3	0.6
		40	−1.3	−1.3
		60	−3.4	−1.3
		80	−2.5	0.2
Water-Glycerol	50	20	0.6	0.1
		40	0.2	0.1
		60	−1.3	−0.1
		80	−2.5	−0.4
	104	20	0.1	−0.3
		40	−1.1	−0.4
		60	−3.6	−0.9
		80	−3.7	0.1
	176	20	0.9	0.2
		40	−1.0	0.1
		60	−4.6	−0.3
		80	−5.4	0.5
Average			1.75	0.60

* For methanol, ethanol, and glycerol values of 100 are 0.94, 0.90, and 0.65, respectively.

Establishing Chemical Cost Control

A year ago Chem. & Met. *published an article by Mr. McNeill describing the functions of the control department and its relation to other divisions of the company. Now he outlines the method by which cost standards are established.*

W. I. McNEILL
Staff of the Manufacturing Vice-President
Colgate-Palmolive-Peet Co., Jersey City, N. J.

COMPARISON of actual and standard factory expense is the best way of determining how economically any plant is operating. Manufacturing economy cannot be judged by profit and loss statements. Losses due to unprofitable selling prices or excess distribution, selling or advertising expense, may result in offsetting manufacturing savings on the one hand, just as profits due to effective sales, advertising or profitable selling prices may be great enough to cover up unprofitable manufacturing.

The purpose of this article is to amplify the suggestions made in the article, "Organization and Control—Basic Foundations for Profitable Chemical Processing" (see *Chem. & Met. for* June, 1938). This will be done by giving a simple illustration of a manufacturing cost set-up with standards for the same, the use of which would be considered insurance against uneconomical manufacturing operations.

Before launching into a discussion of standard processing costs, there are certain pre-requisites, the existence of which we must assume. We assume the existence of an adequate cost accounting system which records plant operations and provides a materials balance; we assume the existence of departments or process centers in the plant. Likewise we assume that manufacturing expenses are accumulated by process centers and distributed according to accepted practices over non-productive and productive departments and over the finished products of productive departments.

On the basis of these assumptions, the manufacturing department can proceed with the determination of standards somewhat as follows:

(1) Do everything possible to perfect the operation to be standardized. This includes a study of machinery and equipment, layout, and methods of handling materials. It may involve time studies, motion studies, changing of machine speeds, elimination of "bottle necks," reduction of scrap, elimination of waste time, etc. If the plant personnel is not equipped to handle the job, it may be necessary to have the work studied by outside experts. In any event, all operating conditions should be as near perfect as it is practicable to have them.

(2) Set standards for each item of controllable cost. In connection with the study of materials, you would derive standards for per cent scrap, per cent loss, yields, etc.

(3) Establish an organization for making use of the comparison between standards and actual results.

Each step in this program is important. If the comparison between actual costs and standards show differences that are always within reasonable allowances, you at least have the satisfaction of knowing that operations are as good as they can be made and that the routine is established so that faulty operation will come to light as soon as it occurs. This, in itself, is good insurance. The chances are, however, that your comparisons will uncover enough operations off standard to more than pay for the cost of the personnel involved.

It is very important that the management be whole-heartedly in favor of the program and be sold on its profit-making possibilities in order to make it pay dividends.

Assuming that all the conditions herein outlined have been met, the work of establishing standards can begin.

Standard Labor Costs—The first step in the standardization of labor should be the assembly of all facts concerning the operation being studied. The number of men working on each operation should be listed, showing their duties and rates of pay. All different conditions of manufacturing—whether for one shift, two shifts, three shifts; one unit, two units, three units, etc.,—should be taken into consideration and labor standards set up for the most economical manufacturing conditions for producing at normal capacity. Consideration should be given to making the standards represent the ideal (and yet attainable) conditions with present equipment. The definition of normal capacity is given herewith: *Normal capacity* may be defined as the total number of production units that could be produced in a normal working day of 1, 2 or 3 eight-hour shifts (excluding time for lunch periods, rest periods, and reasonable shut-downs). Normal shut-downs during an operating period include such items as unavoidable machine breakdowns, regular cleaning, or any other unavoidable reason why 100 per cent absolute capacity may not be reached. If 48 minutes per eight-hour shift should be unavoidably lost, the normal capacity would be 90 per cent of absolute.

Establishment of effective labor standards necessitates the division of labor into two general classes as follows: (1) Labor whose cost per unit of production is constant, regardless of volume, number of shifts operated, or machine units used in production; (2) Labor whose cost per unit of production varies with volume, number of shifts operated, or machine units used

Account for Material No. 1

Charges or Debits	Memo Column	Quantity, Lb.	Unit Price per 100 Lb.	Value
Beginning inventory	.....	100	10.00	$10.00
Receipts	.....	200	11.00	22.00
Total	.....	300	10.67	$32.00
Usages or Credits				
Usage in process No. 1	.....	100	11.73	$11.73
Loss	(Std. 3%)	10	.....	.....
Closing inventory	.....	190	10.67	20.27
Total	.....	300	.....	$32.00

Account for Process No. 1

Charges or Debits				
Usage of material No. 1	100	.....	11.73	$11.73
Yield	2.0	200	.....	.....
Usage of material No. 2	10	.....	7.64	0.76
(Used up in process but its weight is accounted for in the yield)				
Average yield	1,818	.....	.....	.....
Labor cost	.....	.....	.....	0.20
Burden cost	.....	.....	.....	0.75
Total	.....	200	6.72	$13.44
Useages or Credits				
Amount produced	.....	190	6.86	$13.04
Scrap produced	(Std. 3%)	8	5.00	0.40
Loss	(Std. 1%)	2	.....	.....
Total	.....	200	6.72	$13.44

Inventory Account for Process No. 1

Charges or Debits				
Beginning inventory	.....	175	6.00	$10.50
Amount produced	.....	190	6.86	13.04
Total	.....	365	6.45	$23.54
Usages or Credits				
Used in packing 100-lb bags	2	200	6.45	12.90
Closing inventory	.....	165	6.45	10.64
Total	.....	365	6.45	$23.54

Account for Packing 100-lb. Bags

Charges or Debits	Memo Column	Quantity, Bags	Unit Price per Bag	Value
From inventory account for process No. 1	200	2	6.45	$12.90
From inventory account for bags	2	.....	0.50	1.00
Labor cost	.....	.....	.....	0.20
Burden cost	.....	.....	.....	0.05
Total	.....	2	7.08	$14.15
Usages or Credits				
Amount packed and charged to finished goods inventory account	.....	2	7.08	14.15
Total	.....	2	7.08	$14.15

in production. (A convenient example of this is a material supply man who is needed whether one or more units are operating.)

Labor which varies per unit of production should be built up in the form of statements showing the cost at various percentages of normal production capacity. For non-machine operations, normal production capacity levels should be determined from time studies and the analysis of past production records. Before standards are set, all data should be thoroughly digested by everyone concerned and any doubtful facts verified.

Special problems arise on some controllable items of expense which are discussed in the following paragraphs.

Repairs and Maintenance—In starting a standardization program, individual equipment records should be established until such time as complete data are available. In some instances the detailed record can be dispensed with after standards have been set. This depends on the importance of repairs and maintenance in the total cost.

It is obviously impossible to determine a standard for repairs and maintenance which will be applicable to any particular month. A standard for this item will probably represent average expenses for a certain department or process center for a number of months, and perhaps a number of years. In order to determine a stand-

Analysis of Processing Account for Process No. 1

	Per Cent	Unit Price per 100 Lb.	Value
Cost of material No. 1 used	90.91	$11.73	$10.664
Cost of material No. 2 used	9.09	7.64	0.694
Average cost of materials	100.00	.....	11.358
Conversion to average yield of 1.818 resulting in cost of materials per 100 lb. product	$\frac{11.358}{1.818}$	=	6.248

$$\text{Cost of labor } \frac{0.20}{200} \times 100 = \$0.100$$

$$\text{Cost of burden } \frac{0.75}{200} \times 100 = 0.375$$

$$\text{Cost of scrap degraded (4\%)} \quad \frac{8\left(\frac{(6.72-5.00)}{100}\right)}{190} \times 100 = 0.072$$

$$\text{Cost of loss } 2 \times \frac{6.72}{100} \quad \frac{}{190} \times 100 = 0.071$$

Total operation cost	0.618
Total cost of process No. 1 product	$6.866

Comparison of Actual and Standard Costs for Labor and Burden for Process No. 1

Controllable Expense	Standard	Actual	Diff.	Per Cent Diff.
Productive (or direct) labor	$0.17	$0.20	$0.03	17.6
Non-productive (or indirect) labor	0.04	0.05	0.01	25.0
Repairs and maintenance	0.14	0.16	0.02	14.3
Fuel	0.03	0.04	0.01	33.3
Stationery	0.03	0.03	.....	.....
Operating supplies	0.08	0.06	0.02	25.0
Miscellaneous	0.04	0.05	0.01	25.0
Total controllable expense	0.53	0.59	0.06	11.3
Non-Controllable Expense				
Prorated Expense				
Receiving and stores	....	0.05	....	....
Steam — water — power	....	0.12	....	....
Clerical and supervision	....	0.01	....	....
Fixed charges	....	0.18	....	....
Total expense for process No. 1	....	$0.95	....	....

Note: This is a sample for illustration and is not intended to show all classes of burden.

ard, it is necessary to go back to individual repair and maintenance records for each individual piece of equipment. Details showing the costs of materials, labor, and burden that have been applied to each individual machine or class of equipment should be compiled over a long enough period of time to make the records significant. A study of these data will indicate whether repairs have been occurring with greater frequency than necessary, or perhaps, whether an old machine is being maintained beyond the time when it should be replaced by a new one. Experts in repair and maintenance work can set reasonable standards on each machine. The standards for each piece of equipment can be assembled into a standard for the department or process center.

Fuel—Standards for fuel used directly in any department can be determined by having studies made to determine the most economical usage for different volumes of production.

Steam, Electricity, Gas, Water—Standards for these items of controllable expense are handled as for any manufacturing department. The charges to process centers using these materials are based on metered quantities or theoretical usages determined by the use of standard factors per unit of production, per unit of time or other suitable unit. Standard factors may be derived by the use of meters, by special tests or by calculations from existing data. If the factors are properly established the calculated total usages at each accounting period should be reasonably close to the actual amount generated. The plant may be divided into sections if necessary, each of which may be controlled by a meter. Unless one of the items is metered to a given department, it is not customary to consider the cost as a controllable item of expense in that department since the total process center expense is pro-rated according to theoretical usages. Control is obtained by the comparison of the total actual usages with the theoretical usages.

Standards for clerical and supervision expenses, stationery and supplies, operating supplies, and miscellaneous direct expense can be determined by analyzing previous monthly charges and determining the minimum charge necessary for normal operation.

Illustrative Control Accounts and Statements—A simple illustration of a set of accounts for a process industry is shown herewith, together with a cost analysis statement of the processing account and a statement comparing actual and standard costs for labor and burden for that process. The following comments apply to the sample accounts.

It will be noted in the account for Material No. 1 that the closing inventory is priced at the average cost of beginning inventory plus receipts, and that the cost of the loss—or wastage, as it may be in some cases—is allowed to increase the unit price of the usage. When inventories are large in comparison to usage, this method may be unfair because the allowable accuracy in determining the closing inventory may be such that the error might be equal to, or not far from, the quantity used. This would result in distorting the price of the usage and causing marked fluctuations in material costs from month to month. For such cases, it is desirable to prorate the value of the loss between inventory and usage. For the case in question, if this rule were followed, the $32 value would be prorated proportionately over items 100, representing usage, and 190, representing closing inventory, instead of pricing the 190 item at the cost of beginning inventory plus receipts. The standard loss of 3 per cent (arbitrarily based on usage) may be shown on the account for comparison with the actual. The latter, in this case 10 per cent, can then be summarized into a separate report of losses somewhat as follows:

	Material No. 1
Quantity used, lb.	100
Quantity loss, lb.	10
Per cent loss, actual	10
standard	3
Value of loss	$1.07
Losses for preceding five months, per cent	8, 7, 6, 5, 4

Assuming that the 8 per cent loss represents the preceding month, you can judge in this case that the trend in losses is upward and that something ought to be done about it. The money involved is, however, always the basis for the amount of pressure to apply.

In the account for Process No. 1, the average yield is determined by dividing 200 by the total materials added; namely, 110, and differs from the actual yield in that it is a figure used for cost purposes only. Scrap is priced at $5 per 100 lb. If a complete set of accounts could be given, this value would represent the price of the material in the account to which the scrap was returned, assuming it to be lower. For instance, in a series of three operations, if scrap from operation No. 3 were degraded to operation No. 1, it should take the price of the material in operation No. 1.

In Process No. 1 operation account, the cost of the loss is absorbed in the price of the amount produced. The reason for showing the processing account separate from the inventory account for Process No. 1 is that it is more convenient for cost analysis calculations. In the inventory account, the effect of averaging the current month's operation cost with the amount of beginning inventory on hand is shown.

It is noteworthy that the account for packing 100-lb. bags is in terms of finished units packed instead of in terms of pounds, and the conversion figures are shown in the "Memo" column.

Derivation of the figures shown under the analysis of processing account No. 1 is self-explanatory. This analysis gives one the entire facts concerning the operation. (See previous article.) For instance, by spending a little more in labor, you might be able to eliminate a part of the scrap cost. By increasing the time of operation, thereby increasing the burden, the loss might be reduced. This presentation of costs gives all the facts, in usable form, for calculating the cost of improvements, as well as for comparing the operation from month to month.

Comparison of actual and standard costs for labor and burden for Process No. 1 shows the operating personnel how near to standard they were in the performance of current operation. Allowable percentage variations between actual and standard may be determined and investigations started whenever these variations go beyond the allowable limit. Whenever large amounts of money are involved in any given class of expense, it is sometimes desirable to maintain simple daily records to show differences between actual and standard costs so that these differences may be corrected immediately. The need for daily or weekly records depends on local circumstances and the amount of money involved.

The real value from the derivation and use of standards is not in historical facts alone, but is in the use made of these facts in planning future work.

It is unnecessary to state that standards should be changed whenever actual changes are made in operations. By so doing, the plant always has available data to show whether it is operating according to the "one best way," and deviations are automatically brought to the attention of the management. In other words, this control is a form of insurance against the continuation of uneconomical practices.

Equipment Life Extended

Results of tests upon an ammonia converter removed from service for the sake of safety indicated a life of a similar converter operated under the same conditions would be 20 years

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PRODUCTION of synthetic ammonia requires equipment resistant to hydrogen and nitrogen gas mixtures at high pressures and high temperatures. The converter, which is the heart of the synthetic ammonia process, is exposed to the most severe conditions and must be constructed of highly resistant metal. Laboratory tests on metals for determining their resistance to deterioration under certain conditions are generally limited in duration of time. Thus, those responsible for the safe operation of synthetic ammonia plants are somewhat doubtful as to the length of time that the equipment should be used.

An opportunity for making an examination of a discarded piece of equipment was offered when the Great Western Electro-Chemical Co., division of the Dow Chemical Co., scrapped one of its ammonia converters as a precautionary measure after it had been in use for 7½ years. This converter was operated at a pressure of 5,000 p.s.i. with a maximum catalyst temperature of 550 deg. C.

The steel specifications required that a tangential test specimen show at least 14 per cent elongation in a 2-in. gage length and that the last operation before test should be a slow cooling from above the critical range. The forging from which the converter was made had a chemical analysis as follows: C, 0.26; Mn, 0.47; S, 0.017; P, 0.022; Cr, 2.54; V, 0.24; Si, 0.23.

The metallographic examination showed that a zone about 0.01 in. deep from the inside surface was completely decarburized and that extending outward from this zone for a distance of 0.02 to 0.03 in., there was a zone of partially decarburized steel. The remaining thickness of the cylinder wall showed the normal structure for annealed steel of this composition.

The hardness tests indicated that, with the exception of a thin layer of slightly softer metal at the inside surface, the steel was practically uniform in hardness throughout the section.

Vanick, deSveshnikoff, and Thompson (Technologic Papers of the Bureau of Standards, No. 361) found that with a low carbon steel containing more than 2.0 per cent chromium the rate of hydrogen penetration is retarded and that the depth of penetration is definitely limited. Thus it is quite probable that deterioration in this ammonia converter, due to hydrogen penetration, had completely stopped.

The physical properties at normal temperatures of steel in this ammonia converter, before and after the 7½ years service, are shown in the following table.

	Before Service	*After Service*
Ultimate tensile strength	82,500 p.s.i.	81,500 p.s.i.
Yield point.....	42,000 p.s.i.	40,500 p.s.i.
Elongation in 2 in.	28%	28.5%
Reduction of area	60.6%	60.5%
Brinell hardness number	170	161

Thus from the comparison of the strength of the steel before and after the 7½ years of service, the converter has shown very little deterioration. The loss of strength in the converter walls, due to decarburization combined with the slight decrease in the physical strength of the steel, can be best expressed by the statement that the original factor of safety based on the yield point of the steel, was lowered from 3.1 to 2.92.

On the assumption of the same rate of deterioration and the same operating conditions, this converter shell could have been used for 15 years with a consequent reduction of the factor of safety to 2.75 or for 22½ years with a reduction of the factor of safety to 2.6, maximum stress in the walls being 14,400 p.s.i. In determining these factors of safety the yield point of the steel at normal temperatures was used.

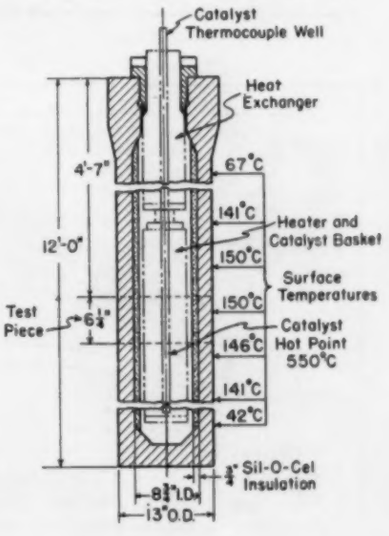
Steel of the composition of this converter loses little strength at temperatures below 325 deg. C. and is highly resistant to creep at 425 deg. C. when stressed below 16,000 p.s.i.

The maximum temperature measured on the outside surface of the converter during service was 150 deg. C. No attempt was made to measure the temperature of the inside surface of the wall. This inside surface temperature would depend upon the efficiency of the internal insulation and heat exchange. By using 1.38 and 25 for the thermal conductivities of the Sil-O-Cel and the steel respectively and assuming 550 deg. C. as the maximum temperature of the inner surface of the Sil-O-Cel liner, the calculated temperature of the inside surface of the converter wall is 192 deg. C. From the results of metallographic and physical tests, it is fairly evident that no portion of the converter wall had been subjected to temperatures high enough to decrease its strength. The fact that there were no appreciable changes of inside or outside diameters of the converter would show that the temperatures had not been high enough to produce harmful creep of the steel walls.

From the results obtained by tests upon the discarded converter, a safe estimate of the life of a similar converter, operated under the same conditions, would be 20 years.

The physical tests and the metallographic examinations of the discarded ammonia converter were made by The National Bureau of Standards and their results checked closely with similar but entirely separate tests made by the University of Illinois and the Midvale Steel Co.

Converter was a hollow forging



Impervious Carbon Equipment

An impervious treatment in which a synthetic resin formed in the pores normally present in carbon and graphite reduces the porosity to practically zero and eliminates permeability. This new material is discussed with reference to chemical resistance and heat transfer properties. It is, in most cases, superior to carbon or graphite as a material of construction for the process industries.

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National Carbon Co.
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A GENERAL OUTLINE of the physical and chemical properties of carbon and graphite as used in chemical engineering is given. Karbate (impervious carbon and graphite) is discussed especially with reference to its chemical resistance, and heat transfer properties. Results of tests run to determine overall heat transfer using Karbate No. 2 in liquid to liquid, and condensing vapor to boiling liquid systems are given and types of equipment cited.

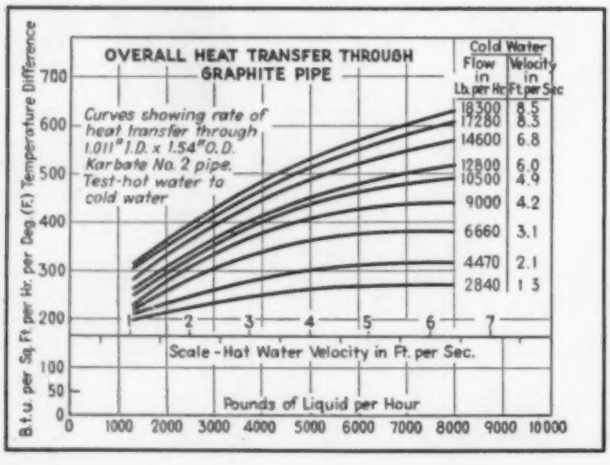
The principal sources of raw materials for structural carbon are anthracite coal and petroleum coke. After removal of volatile matter from these materials, they are mixed with a coal tar bonding agent, formed under high pressure, and baked to a temperature sufficiently high to crack the hydrocarbons, leaving a carbon bond. The entire mass is then carbon bonded with carbon, and is known as amorphous carbon. To produce graphite, the temperature is raised still further to convert all of the amorphous carbon to the graphitic state. Contrary to popular belief, this change occurs without appreciable change in external particle structure. There are, however, significant changes in some of the physical characteristics. For example, the electrical resistivity decreases approximately 60–75 per cent, and heat conductivity increases about 2500 per cent.

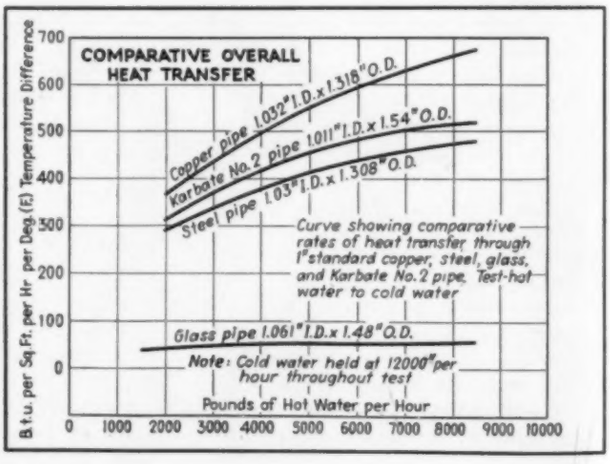
While carbon is definitely machinable, it is abrasive and requires a special machining technique; graphite made from the same raw materials machines like hard wood and can readily be machined to almost any desired shape.

There is no reason to discuss in detail the chemical behavior of carbon in either the amorphous or graphitic state. It is, of course, a reducing agent, and is, therefore, subject to reaction where atomic oxygen is present, and it combines with many metals to form carbides.

While the majority of these reactions take place only at elevated temperatures, such as occur in the production of iron from ore, there are also low temperature reactions between carbon and strong oxidizers, such as oleum, chromic acid, aqua regia mixed acid, etc. In a majority of these cases, graphite is slower in reaction than carbon, as is illustrated by the critical oxidation tem-

Based on a paper presented before the Akron, Ohio, meeting of the American Institute of Chemical Engineers, May 16, 1939.


OVERALL HEAT TRANSFER THROUGH GRAPHITE PIPE
Curves showing rate of heat transfer through 1.011" I.D. x 1.54" O.D. Karbate No. 2 pipe. Test-hot water to cold water
Cold Water Flow in Lb. per Hr.
Velocity in Ft. per Sec.
18300 8.5
17280 8.3
14600 6.8
12800 6.0
10500 4.9
9000 4.2
6660 3.1
4470 2.1
2840 1.3
Scale - Hot Water Velocity in Ft. per Sec.
Pounds of Liquid per Hour
B.t.u. per Sq. Ft. per Hr. per Deg. (F.) Temperature Difference


COMPARATIVE OVERALL HEAT TRANSFER
Copper pipe 1.032" I.D. x 1.318" O.D.
Karbate No. 2 pipe 1.011" I.D. x 1.54" O.D.
Steel pipe 1.03" I.D. x 1.308" O.D.
Curve showing comparative rates of heat transfer through 1" standard copper, steel, glass, and Karbate No. 2 pipe. Test-hot water to cold water
Glass pipe 1.061" I.D. x 1.48" O.D.
Note: Cold water held at 12000# per hour throughout test
Pounds of Hot Water per Hour
B.t.u. per Sq. Ft. per Hr. per Deg. (F.) Temperature Difference

perature in air, which for carbon is about 350 deg. C., and for graphite 450 deg. C. Aside from these reactions and a few isolated cases, the material is inert.

The physical properties of most of the available grades of carbon and graphite have been reported by F. J. Vosburgh (*Chem & Met.*, vol. 45, p. 658). An examination of these data will show that in addition to the above-mentioned property of being chemically inactive in a wide range of conditions, reasonable mechanical strength is available.

As normally produced, all of these materials have had a porosity of around 25 per cent, and although this has not been a serious objection in most applications, it has frequently precluded taking advantage of the chemical properties of carbon in locations where permeability to fluids has been a serious consideration.

To overcome this objection, an impervious treatment has been developed recently, which has been under laboratory and commercial test for the past three years. The process involves the formation of a synthetic resin in *situ* in the pores normally present in carbon and graphite. The product, known as Karbate, is therefore carbon or graphite, as the case may be, with porosity reduced to practically zero and permeability eliminated. While the resin itself does not have the same chemical properties as carbon, great care has been exercised in producing a material in which the chemical resistance has not been greatly changed except in a few respects. The resin is subject to oxidation in air at lower temperatures than the base material, and is subject to thermal decomposition above 170 deg. C. The strength of Karbate is about double that of the base material. Results of tests for chemical resistance which illustrate the wide range of applications are summarized in a table on page 364.

To date, Karbates are not available in all of the sizes in which the base materials are made. However, to give some idea of available sizes, tower sections up to 24 in. O.D. can be produced. Large plates, tanks, etc., have been produced by cementing slabs together. The individual slabs run to 6 ft. in length, and the cement used to produce the large sections is fundamentally the same as the impregnating material.

The widest application of Karbates to date is in pipe form. A complete line of pipe and fittings from ½ in. I.D. to 6 in. I.D. is available. Either threaded or flanged connections are regularly used. If threaded, a straight thread rather than tapered is made, and is generally best applied on a lathe. Where much cutting and threading is to be done in the field, Karbate No. 2 (graphite base) is recommended because of the ease with which it is machined. With a small amount of practice, a maintenance crew can cut, thread, and fit lines without undue breakage or difficulty.

Physical properties of these materials show that they are strong. For example, pipe in most sizes is regularly tested, at the factory, at 125 lb. per sq. in. hydrostatic pressure. It must be remembered in handling them, however, that they cannot safely be sprung into place as can the more malleable and ductile metals. Aside from preventing this transverse loading and sudden mechanical shock, no unusual precautions are necessary.

One of the most interesting characteristics from the chemical engineer's standpoint is the unusually high heat conductivity of Karbate No. 2 (graphite base). In order to compare this factor with some of the materials generally available for chemical construction purposes, the following table has been assembled:

Material	K (B.T.U./Sq.Ft./deg.F./Hr./Ft.)		
Copper	224	*	32 deg. F.
Aluminum	75–131	‡	(Room Temp.)
Brass (rad)	93	‡	(Room Temp.)
Karbate No. 2 (graphite base)	75	...	200 deg. F.
Admiralty	65	‡	(Room Temp.)
Tantalum	32	‡	(Room Temp.)
Hi Silicon Cast Iron	31	‡	(Room Temp.)
Steel, 1% Carbon	26	†	64 deg. F.
Chemical Lead	20	‡	32–212 deg. F.
Antimony Lead	17–20	‡	32–212 deg. F.
18–8	7.3–17.0	‡	32–212 deg. F.
Nickel Chromium (17% Ni, 13% Cr)	8.5	‡	(Room Temp.)
Karbate No. 1 (carbon base)	3	...	100 deg. F.
Boro Silicate Glass	.63	†	86–167 deg. F.
Chemical Stoneware	.07	‡	.....

* International Critical Tables
† "Heat Transmission"—(McAdams, 1933) Pg. 314
‡ Chemical & Metallurgical Engineering, Nov. 1938, pp. 633–659

Examination of this table will show that while Karbate No. 2 does not compare in heat conductivity with those metals showing the highest values, it is well above materials frequently used because of their chemical resistance and also sufficiently high so that in most applications, the h value of a ⅛ in. to ¼ in. walled tube is sufficiently high so that it does not materially affect the overall U value of a liquid to liquid system.

In order to check this from a practical standpoint, a series of tests has been run to determine the overall U value of a single horizontal, concentric tube, countercurrent flow system operating with hot water in the inside and cold water in the annulus. Entering hot water varied from 200-212 deg. F., and cold water from 40 deg. to 70 deg. throughout the tests.

The summarized results appear on Fig. 1. Fig. 2 shows the comparative overall U between hot and cold water in the same system where other materials of construction were substituted for Karbate No. 2, indicating clearly that the h value for this material is sufficiently high to be quite thoroughly masked by film factors in the range of design velocities normally used in heat exchange applications.

It should be admitted that these tests were run to gain practical rather than highly theoretical data, and that no serious study of film factors was attempted. It is interesting, however, to make some rough comparisons of the overall heat transfer results obtained on Karbate, copper and iron pipe. In the tests, the quantity of water flowing in the annulus was kept constant, and therefore, the heat transfer coefficients shown on Fig. 2 have not allowed for change in annulus caused by substituting the smaller copper and iron pipe (1.3 in. O.D.) for the 1.5 in. O.D. graphite pipe. The curves also base the overall heat transfer coefficients on the mean diameter

Physical Properties of Impervious Carbon and Graphite

	App. Dens. Avg.	Wt./ Cu.Ft. Avg.	Porosity % Avg.	Tens. Strength Lb./ Sq.In. Avg.	Compr. Strength Lb./ Sq.In. Avg.	Trans. Strength Lb./ Sq.In. Avg.	Long. Modul. of Elas. x10⁶ Lb./ Sq.In. Avg.	Spec. Res. Ohms/ In.³ Avg.	Long. Coef. Therm. Exp. x10⁻⁶ Avg. /°F.	Ther. Con. BTU/ Hr./ Sq.Ft. /°F/ Ft.–Avg.
Karbate No. 1 Tubes										
1/2" 2" I. D. inc.	1.77	110	1.2%	1,700	10,500	4,170	29.0x10⁶	.00164	.27	3.0
Over 2" I. D.	1.76	110	3.2%	2,000	10,500	4,640	26.0x10⁶	.0016	.33	2.8
Karbate No. 2 Tubes										
1/2"–2" I. D. inc.	1.86	116	.9%	2,600	8,900	4,650	23.0x10⁶	.00034	.23	85.
Over 2" I. D.	1.91	119	.4%	2.350	10,500	4,980	21.0x10⁶	.00033	.24	75.

of the pipe in each case. The theoretical overall heat transfer coefficient for each of the systems has, therefore, been calculated by using the formula $h = \frac{(5.6 + .058t)(G')^{.8}}{D'^{.2}}$

where h = coefficient of heat transfer (film), t = water temperature (F. deg.), G' = lb./sq.ft./sec., and D' = diameter (in.). D' for the annulus is figured on equivalent diameter by the formula: $De = \frac{D2^2 - D1^2}{D1}$

h for copper pipe (.15 in. wall) is taken as 18,000.

h for Karbate pipe (.25 in. wall) is taken as 3,600.

h for iron pipe (.15 in. wall) is taken as 2,100.

Below are summarized the test data and test results, as well as the calculated overall coefficients on the three types of pipe, at the point on the curves corresponding to 5,000 lb. hot water per hour flowing through the pipe, and 12,000 cold water per hour through the annulus.

	Hot Water		Cold Water		BTU/Sq.Ft./Hr./deg.F. Based on Mean Dia.	
Pipe	Lb./Hr.	Av Temp. F. deg.	Lb./Hr.	Av. Temp. deg. F.	Calculated	Observed
Copper..	3230	201.6	12,355	46.9	495	550
Karbate.	4963	190.2	12,697	71.06	510	450
Iron.....	4717	202.7	12,560	46.3	352	410

An examination of these data indicates that the observed overall heat transfer coefficient for Karbate as shown by test is 88 per cent of the theoretical value, whereas the iron and copper systems show 107 per cent and 111 per cent, respectively, of theoretical.

When consideration is given to the percentage of error in tests of this type, as well as to the fact that Karbate does not depend on the formation of a low coefficient film for its chemical resistance, it seems logical to assume that no serious error will result from using accepted design calculations for this material, and that barring precipitated scale deposits, the original heat transfer will be permanent. Practical results in the field indicate that this is true.

In the Karbates, therefore, are available unusual chemical resistance, ample strength, ease of handling and assembly, machinability and high heat conductivity.

Heat exchange equipment of concentric tube, simple S bend and bundle and shell type have now been in service for periods ranging up to three years in such difficult conditions as hydrochloric, hydrofluoric, hydrofluosilicic, hydrofluoboric, phenolsulphonic, phosphoric acids, and rayon coagulating baths, and is being used for steam heating of liquids as well as for cooling.

A wide range of data on multiple tube bundles for open tank evaporation is not available at present. However, some information of a general nature has been collected and is presented as a matter of general interest. The equipment under consideration was built to meet certain space and shape limitations and was not necessarily designed for most efficient heating. The unit had an outside tube area of approximately 23 sq. ft. and a total area of approximately 34 sq. ft. including the tube headers, but excluding steam inlet and condensate mains. Operating horizontally in a tank 10 ft. x 6 ft. x 2 ft. deep with the condensate line coming over the tank wall to a trap, this unit performed as follows with the tank full of water boiling at atmospheric pressure:

Gage Steam Pressure	Lb. Condensate per Hour	BTU/Sq.Ft. of Tubes /Hr./F.deg. (23 Sq.Ft.)	BTU/Sq.Ft. (Total) /Hr./F.deg. (34 Sq.Ft.)
25 lb.....	413	295	205
50 lb.....	914	410	280
75 lb.....	1,477	500	375

The same unit operating vertically in the evaporation of an aqueous solution of metal salts (chlorides) boiling at 234 deg. F., and operating under 65 lb. steam pressure is reported to produce a 400 B.T.U./sq.ft./hr./F. deg. rate based on the total area of 34 sq.ft.

The manufacture of tube bundle and shell exchangers normally follows conventional floating end design as applied in the manufacture of metal tube heat exchangers. In this case, Karbate tubes are cemented into Karbate tube sheets with a cement having the same chemical properties as the impregnent, so that the entire bundle is uniformly chemically resistant. Nozzles, heads, etc., may be Karbate lined where contact with corrosive materials indicates this procedure. Test and operating pressures are obviously dependent on tube sheet diameters. At the present time, however, equipment of this type can be designed to withstand 100 lb. per sq.in. test hydraulic pressure even in 25-in. diameter sizes. Higher test pressures can be designed for in smaller diameters.

In this discussion the authors have endeavored to point out the fundamental chemical and physical character of carbon and graphite products as now made for chemical engineering purposes.

The author's thanks are due his associates for their assistance in the preparation of this paper, and to many members of the chemical engineering profession for their suggestions and willingness to put new products to commercial tests.

CHEMICAL RESISTANCE OF IMPERVIOUS CARBON

Group I. Karbate Resistant To		
Reagent	Concentration	Temperature
Sulphuric acid.....	66°Be.—96%	Up to 80°C.
Sulphuric acid.....	Up to 50%	Boiling or 120°C.
Hydrochloric acid.....	All conc.	Boiling
Hydrobromic acid....	40%	Boiling
Phosphoric acid.....	50%	Boiling [1]
Sulphurous acid.....	7%	Room
Formic acid.....	90%	Boiling
Acetic acid.....	100%	Boiling [1]
Boric acid.....	25%	Boiling
Oxalic acid.....	25%	Boiling
Citric acid.....	25%	Boiling
Lactic acid.....	25%	Boiling
Methyl alcohol.....	100%	Boiling
Ethyl alcohol.....	95%	Boiling
Isopropyl alcohol.....	100%	Boiling
Butyl alcohol.....	100%	Boiling
Amyl alcohol.....	100%	Boiling
Octyl alcohol.....	Technical	100–150°C.[2]
Carbon tetrachloride..	100%	Boiling
Ethylene dichloride...	100%	Boiling
Acetone.....	100%	Boiling
Methyl isobutyl ketone	100%	Boiling
Isopropyl ether.....	100%	Boiling
Isopropyl acetate.....	100	Boiling
Dioxan.....	100%	Boiling [3]
Benzene.....	100%	Boiling
Manitol.....	25%	Boiling
Sodium chloride.....	25%	Boiling
Ferric chloride.....	15%	60°C.[4]
Aluminum sulphate...	Saturated	Boiling
Hydrofluoric acid.....	60%	Boiling
Fluosilicic acid.....	100%	Boiling
Alkalis.....	All conc.	40°C.

Group II. Karbate At First Attacked By And Then Resistant To		
Acetic anhydride.....	100%	Boiling
Oleic acid.....	100%	Boiling
Stearic acid.....	100%	135°C.
Tartaric acid.....	25%	Boiling
Petroleum oil.....	100%	Boiling
Kerosene.....	100%	160°C.
Gasoline.....	100%	Boiling
Glycerine.....	100%	135°C.
Nitrobenzene.....	100%	135°C.
Phosphoric acid.....	Up to 85%	Room
Acetic acid.....	Up to 100%	Room

Group III. Karbate Attacked Seriously By		
Bromine.....	100%	Boiling
Chlorine (wet).....	.....	.....
Sodium hypochlorite..	5%	Room
Chromic acid.....	10%	Room
Nitric acid.....	1%	Room
Ferric chloride.....	15%	Boiling

[1] See also under Group II.
[2] Poor grade; exact identity unknown.
[3] 1, 4-diethylene oxide.
[4] See also under Group III.

Modern Molasses Distillery

ETHYL ALCOHOL is produced from several raw materials. The most important of these materials are: molasses, grain (corn, malt, rye, etc.), ethyl sulphate, sulphite liquor, pineapple juice, grapes, raisins, cider, corn syrup, fermented liquor and manioca meal. In the year 1936–37 202,631,000 gal. of molasses and 198,468,000 lb. of corn were thus consumed.

Its manufacture from molasses is much simpler than from grain. The milling, cooking and malting are omitted, consequently the capital investment and operating expense, are much less. The process consists of the following steps: (1) weighing of the molasses, (2) mixing with water, (3) sterilizing, (4) cooling or diluting with cold water, (5) preparation of the pure culture yeast, (6) charging the fermenters with the dilute molasses, (7) addition of pure culture yeast, sulphuric acid and yeast food, (8) fermentation and (9) distillation.

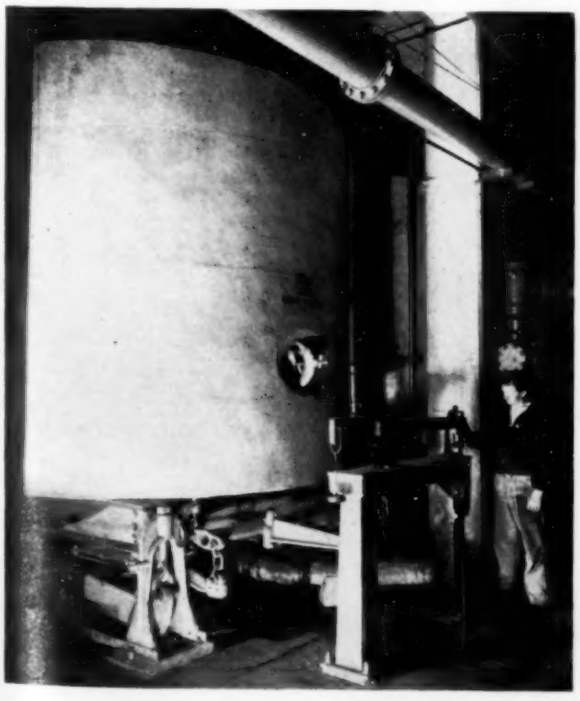
This process is used for making alcohol by the Pennsylvania Alcohol Co., subsidiary of the Pennsylvania Sugar Co., Philadelphia. The plant is located near the river since the molasses is transported from Cuba, Hawaiian and Philippine Islands and other sources by boat. On arrival it is pumped to storage tanks, each holding several million gallons.

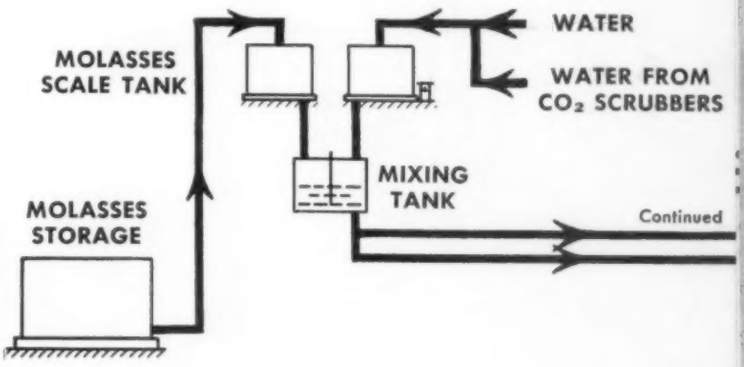
From the storage tanks molasses is pumped to the weigh tanks in which it is carefully measured before entering the process. The first operation is to dilute the molasses with water. From the mixers the mash, as it is called, is pumped into the fermenters and the sulphuric acid and ammonium sulphate are added. The acid inverts the sucrose into dextrose and levulose, while the sulphate acts as a yeast food. Five per cent of its volume of ripened yeast is introduced.

Fermentation requires between 36 and 48 hours. The "beer" containing from 6.5 to 8.5 per cent alcohol by volume is then pumped to the still house where it is de-alcoholized, producing 95 per cent alcohol.

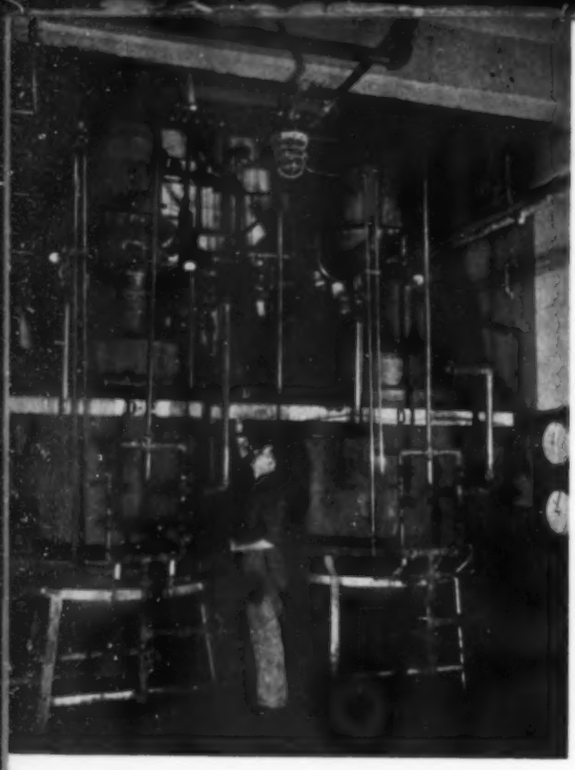
The essential steps in the process of making alcohol from molasses by the Pennsylvania Alcohol Co. are shown in the accompanying diagrammatic flow sheet which commences on this page and continues on the three pages that follow. Most of these steps in the process are illustrated by photographs.

From storage tanks molasses is delivered to weigh tanks in order that this raw material entering the process may be accurately measured.

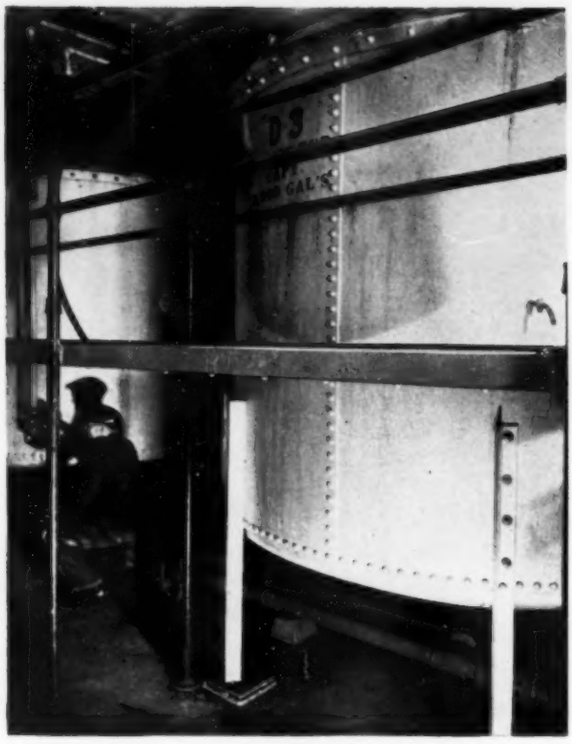




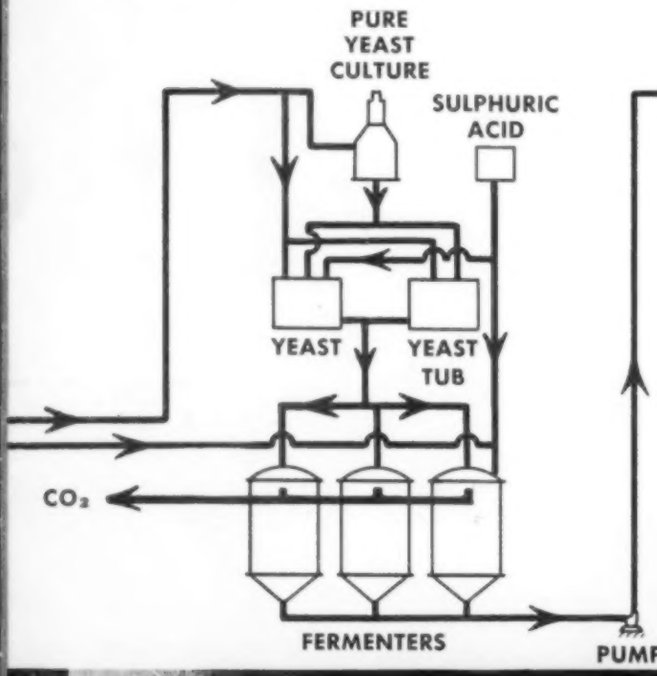
Molasses, which is received by steamers from several sources, is stored in large steel tanks, each holding several million gallons. In the rear is the plant of the Pennsylvania Alcohol Co., subsidiary of the Pennsylvania Sugar Co., Philadelphia.



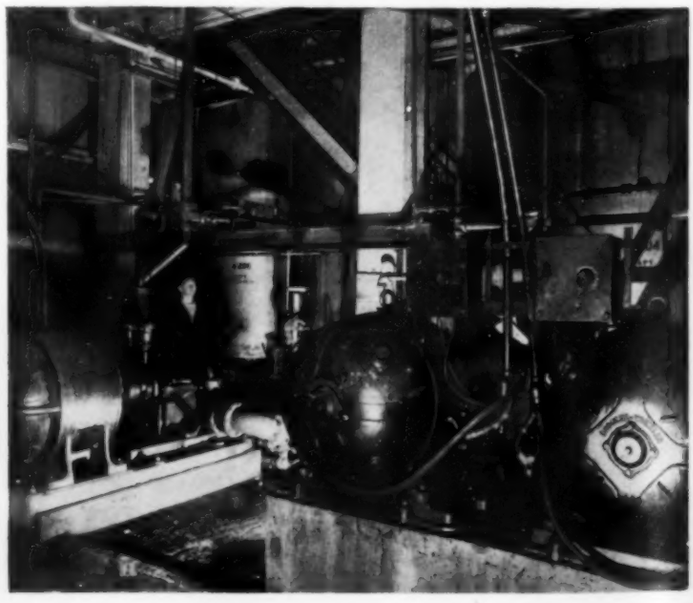
Pure yeast culture takes place in these vessels. They are located near the top of the building in order to take advantage of gravity flow of materials in the several stages of fermentation.

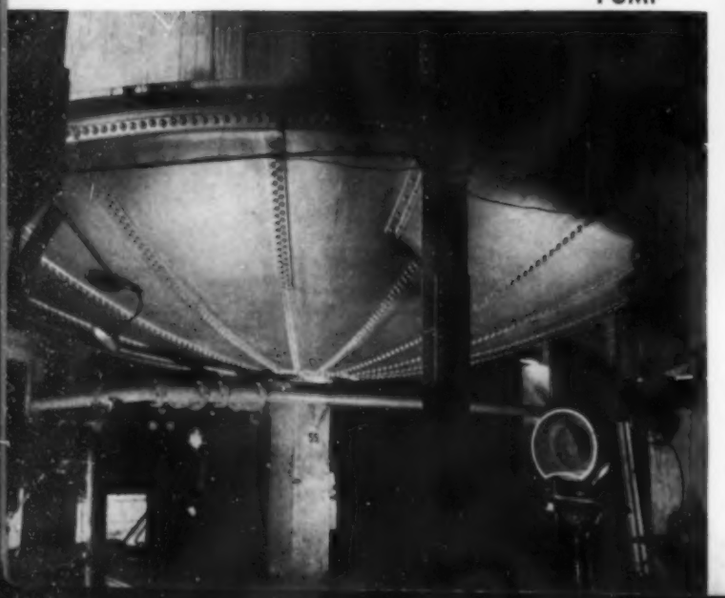


The second step in the fermentation process. A portion of the yeast from the copper vessels flows into these tubs and molasses diluted with water is added. The tubs have a capacity of 5,000 gal. each.



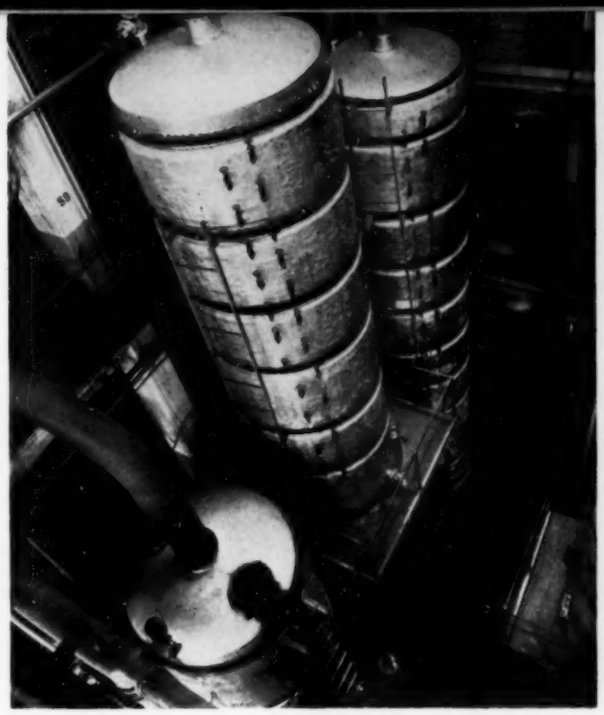
Three pairs of pumps are used to convey the molasses to the mixing tanks (where four parts of water are added to one part of molasses) and from these tanks to fermenters, and the fermented mash "beer" to the stills.



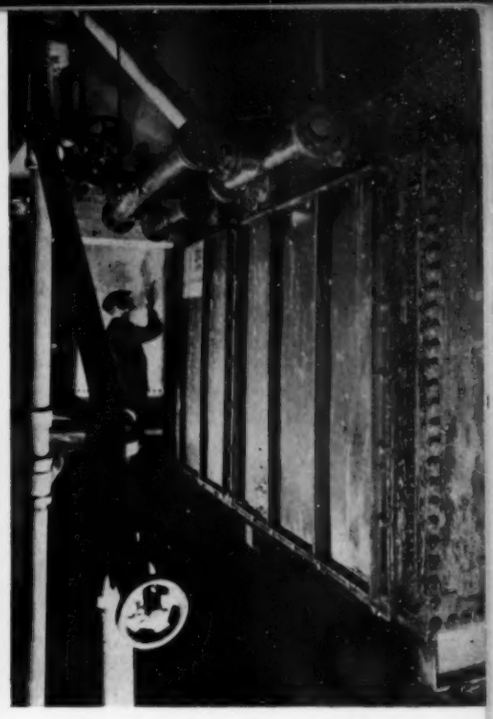


When this larger mass of molasses has been fermented it is pumped into the fermenters. The fermenters have a capacity of 100,000 gal. each. This operation is completed within 36 to 48 hr. The alcohol content of fermented mash is from 6.5 to 8.5 per cent by volume.

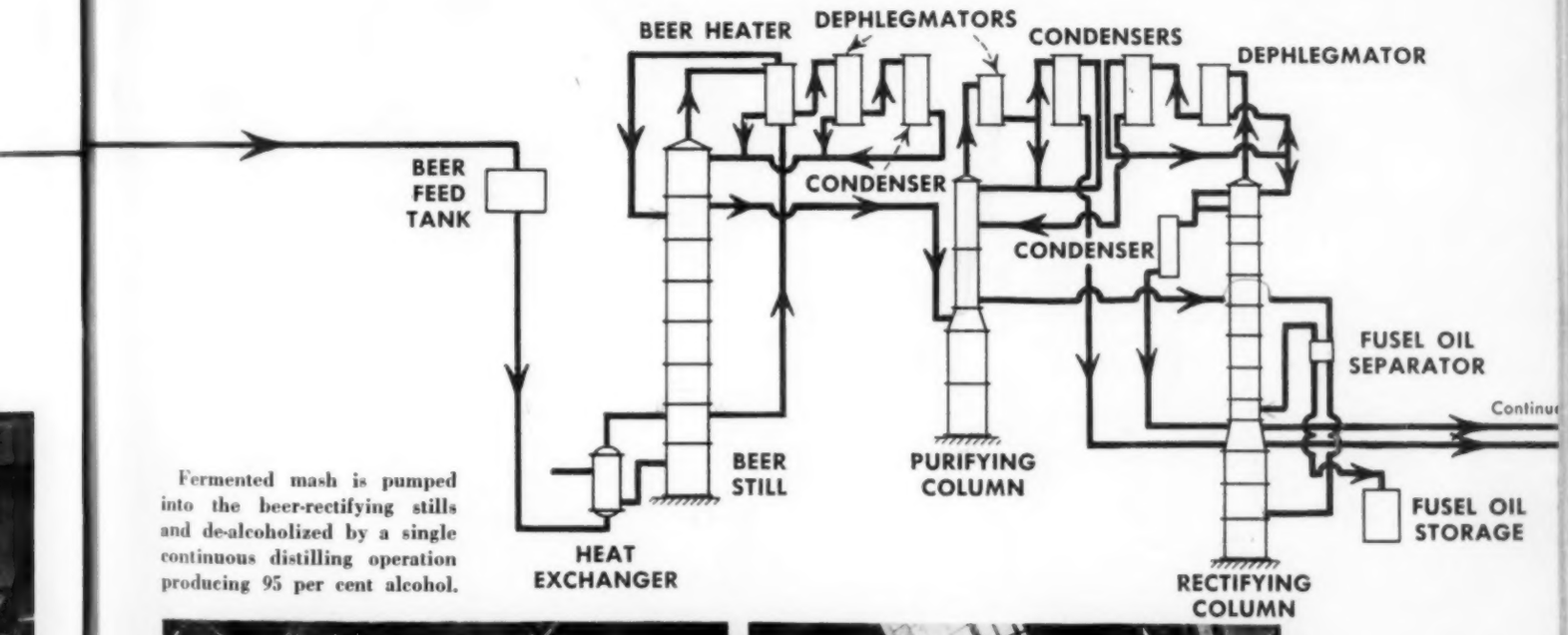
A Chem & Met PICTURED FLOW SHEET



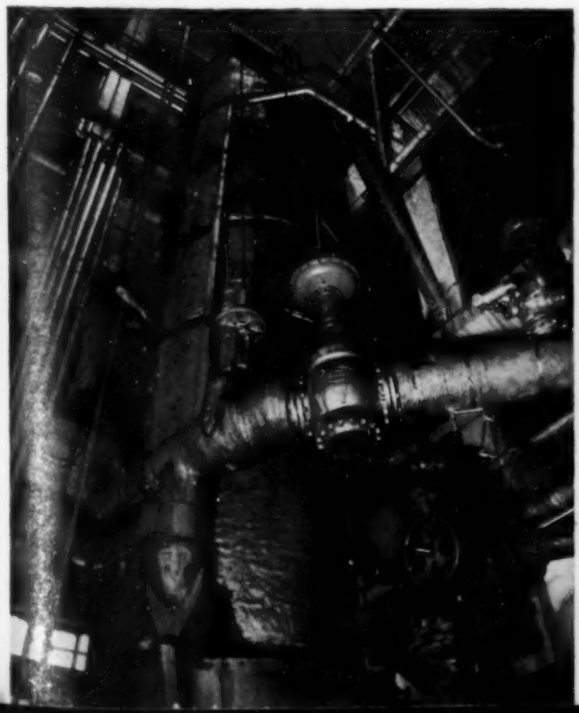
One of the beer stills is shown in the lower foreground, an aldehyde still on the platform and a rectifying column in the background.

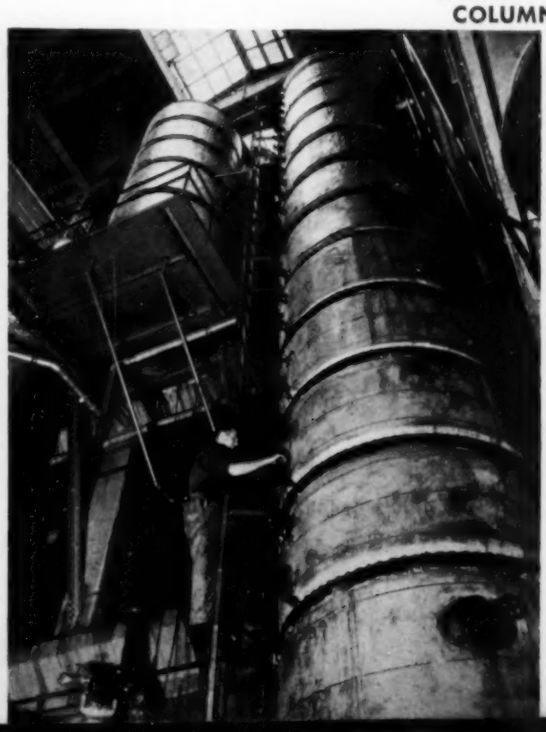


The feed for the beer stills is passed through the heat exchanger shown on the extreme right. The heat being supplied by the slop from the beer still.



Fermented mash is pumped into the beer-rectifying stills and de-alcoholized by a single continuous distilling operation producing 95 per cent alcohol.

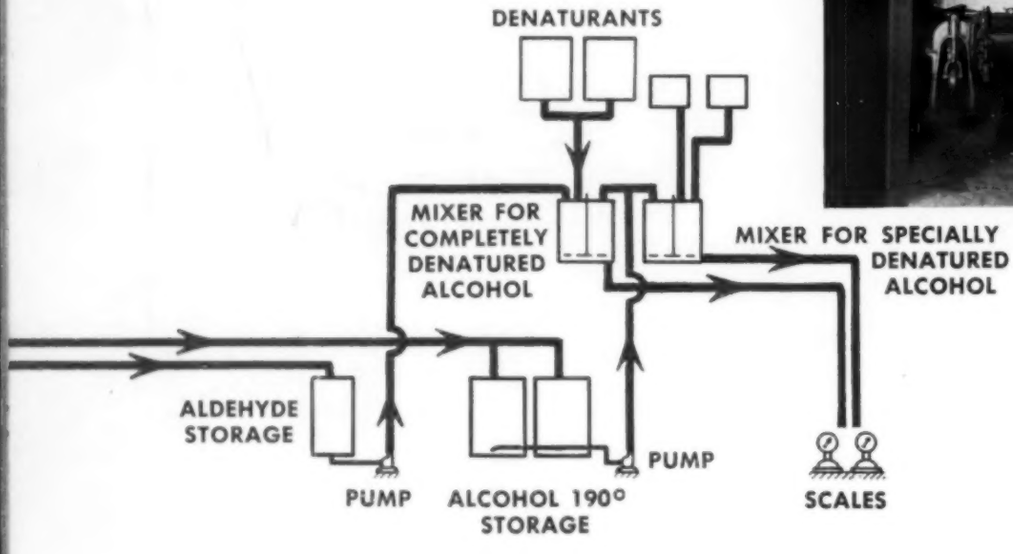




One of the rectifying stills and an aldehyde still in the alcohol plant of the Pennsylvania Alcohol Co. at Philadelphia.

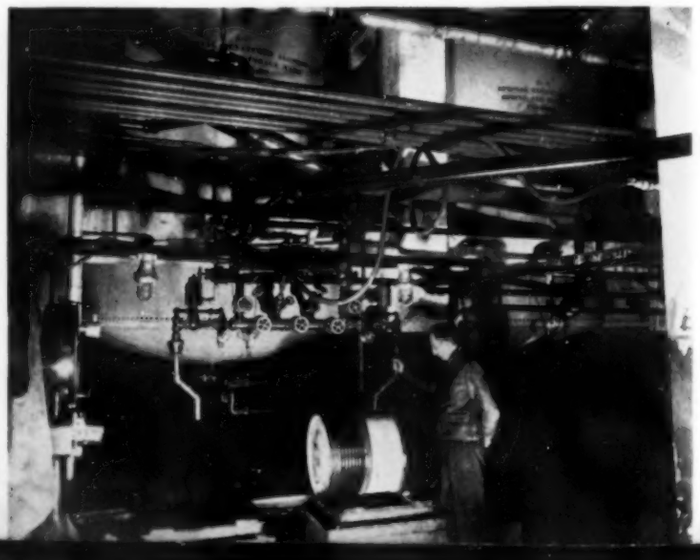
Filling a drum with alcohol from one of the many tanks in the bonded storage room. Notice that the electric light bulbs are carefully protected.

The alcohol to be denatured is measured in this weigh tank, the denaturants added, and then pumped to storage.



After the distilling operations are completed the alcohol flows down to government supervised weigh tanks. From these tanks it is pumped to bonded storage.

View in the denaturing house where a portion of the alcohol is denatured. The drum is being filled while on the scale in the foreground.



China Resists and Reconstructs

Chemical industry like all industry in China was hard hit by the recent Japanese invasion. However, many plants have been moved to the interior and the rapid recovery of the industry shows amazing resilience.

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***AS WE READ** in the daily press of the appalling loss of life and the destruction of millions of dollars worth of property as a consequence of the present Sino-Japanese conflict, we are led to wonder what has happened to industry in China. Dr. Liao, a professor of chemical engineering who obtained much of his technical training at our own Ohio State University, tells a surprising story of reconstruction and even progress, which shows the irrepressible courage of the Chinese people. His remarks apply to all manufacturing industry, but his viewpoint is that of a chemical engineer.*—EDITOR.

Movement of industry in China has been inland, away from the path of Japanese invasion. Map shows the industrial centers of China before and after the war

PRIOR TO THE WAR of resistance against Japanese invasion which started on July 7, 1937, the Chinese people were well on the way to modernizing industrial enterprise in their great country. However, the invasion quickly put a stop to progress. Since that time, China has begun her program of economic reconstruction, which is closely paralleled by the strengthening of national defense. In all this work her policy has been to "resist and reconstruct."

Before the present war, the most important industrial districts involving chemical process industries were as follows:

1. Tientsin-Tangku—known for its wool, textile, cement, flour and chemical industries.

2. Shanghai—The largest port in the Far East, Shanghai was the birthplace of Chinese industry. Therefore it has always been the most important industrial center in China, having every kind of industry under the management of both Chinese and foreign nationals. Among them were textiles, acids and soda, alcohol, paper, flour, shipbuilding and electrical apparatus manufacture.

3. Kwangtung-Kwangsi — Private companies here were engaged in textile, dyeing and rubber goods manufacturing; governmental enterprises included acids, sugar refining, alcohol, textiles and cement.

3. Hongkong-Singapore—Industries carried on by Chinese in these ports were rubber, electrical supplies, textiles and dyeing, and cosmetics manufacture.

In addition there were many more important industrial districts, such as Tsingtao, Soochow-Wusih, Wuhan, etc.

However, since the war such places as Tientsin, Tangku, Tsingtao, Shanghai, Soochow, Wusih, Canton and Wuhan were invaded one after another and industrial establishments in those districts could not escape the ruthless destruction resulting from modern military operations. In the two largest districts, Tientsin and Shanghai, only those plants inside foreign

concessions remained intact and they are producing at the present time. All others were destroyed, occupied, looted or dominated by the Japanese and recovery is impossible, at least for the present. Fortunately, some of them had previously made a wholesale evacuation into the interior under the Government's Wartime Industrial Act. Part of them had moved their plants to Hongkong, the British colony in the Far East. Recently through governmental promotion, industrialists and capitalists have shifted their attention to development and investment in the Southwest provinces.

In order for the big nation to carry on its protracted war of resistance, it is essential to establish a measure of self-sufficiency. Therefore China's industrial centers have been modified and transplanted as described in the following paragraphs.

New Industrial Centers

Chungking—The city of Chungking has become China's wartime capital; so many new plants have been added to the original ones. The district was originally known for its textiles, foods and consumer goods manufacture. Now the tendency is toward the erection of heavy chemicals plants, such as those for the manufacture of acids and soda, and motor fuels from vegetable oils.

Interior Szechuen—The province of Szechuen aside from the Chungking district, is a district where natural gas and rock salt are abundant. New plants have been erected to make use of the local resources, such as the recovery of motor fuel from natural gas, refining of rock salt, and the electrolysis of brine.

Kunming—Since the war Kunming has become the most convenient communication center with the outside world. Industrial reconstruction has been started to some extent and has aroused interest among overseas Chinese capitalists. For instance, the Hu brothers in Singapore recently invested a large sum in this district, organizing the South Western Industrial Development Co. The Ministry of Economics also decided to erect acid, soda and machinery manufacturing plants here.

Hunan-Kwangsi—In these two provinces the industrial development has been carried out to some extent along the new lines. Electrical supplies and rubber goods plants have already been started.

Shanghai—Industry here is now limited to foreign concessions with some plants moved in from the outside. However, all are small-scale plants and merely maintain their past status.

Tientsin—The conditions in Tientsin are different from those of Shanghai, which was much more subject to Japanese military raids. Therefore only a small number of plants now exist inside the concessions.

Hongkong-Singapore — Hongkong has enjoyed a boom since the war and many new plants have either moved or been erected there. Singapore's situation remains unchanged.

Northwest District—With Sian as a center, the industries in this district have been quite active. Besides the original ones, development of the textile industry is greatly emphasized; mining of coal, iron ore, and gold has been strengthened; an alcohol distillery was erected in Hanchung; wool textile and machinery manufacturing plants have been established in the far Northwest district; and new work includes the extension of the original small-scale, hand-made paper, leather, matches, and canning goods plants.

To a large extent, industry has been subsidized by the government, which has been especially active in financing direct munition industries such as iron, steel and copper; industrial machinery industries, mining industries; and electrical power industries. Likewise the government has cooperated in the movement of private industry from the coast into the interior. Up to the end of last year, movement of industry as reported by the government was summarized as shown in the accompanying tables.

Movement of Chinese Industry

Kinds of Plants	No. of Plants	Tonnage of Equipment Evacuated
Machinery and Hardware	64	8,000
Chemical	22	2,200
Electrical Supplies	18	3,200
Printing	12	1,700
Textiles	7	32,600
Porcelain and Glass	5	3,400
Shipbuilding	4	170
Coal Mining	2	8,600
Total with others	341	65,200

New Localities

Province	No. of Plants
Szechuen	124
Western Hunan	110
Shensi	20
Kwangsi	15
Others	72

It goes without saying that this tremendous upheaval of industry is fraught with widespread privation and suffering. Fortunately, the people were able to fall back on all sorts of handcraft manufacture that has prevailed in China for centuries. The Ministry of Economics encouraged the farmers in their small undertakings and organized cooperative companies throughout the Southwest provinces to strengthen industry in the rural homes. The Government has been especially helpful in making market surveys, spreading skilled labor from the war zones to useful areas, lending proper industrial equipment to the farmers and instructing them in the technique of manufacturing such articles as stockings, towels, shirts, soaps, leather, paper, inks, and other commodity goods.

These handcraft industries do, however, have many shortcomings. They continue to be conducted in a primitive way because of innumerable reasons. Some of the most important internal reasons are: the concept of conservatism, unscientific organization, lack of skilled labor, lack of capital, lack of encouragement through scientific and engineering research. Then there are a number of external reasons, such as lack of legal control of tariff, extensive national and local taxes, unsolved safety problems, and an inadequate communications system. Because of some of these reasons, large quantities of Japanese goods have been dumped on the Chinese market. The government has been campaigning to keep the people from buying these goods, but because they are often disguised, the problem is a difficult one.

Conclusion

Throughout all this reconstruction, the Chinese leaders have maintained that in the rebuilding of a new China, the nation's virtues should be preserved and reconstruction must be planned to suit the nation's environment. From past experience they have found that the blind copying of imported theories is bound to failure. In accordance with these ideas, the policy has been to put the emphasis first on commerce, second on industrial manufacturing and finally on the connection between agriculture and industry. Concerning the establishment of heavy industries, of which China has practically none, it is of primary importance to study the market conditions in the country with reference to those in foreign countries and to consider the demands of peace as well as war time. With these considerations in mind, China goes on to build new industrial enterprises on the ruins of the old.

Processing of Viscous Materials

Since the arrival of "The Plastic Age" the number of materials of high viscosity with which the chemical engineer must deal has been greatly increased. Such materials requires special techniques, especially in mixing, handling, pumping and filtering

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VISCOSITY is a property possessed to varying degree by all substances. When materials of high viscosity are encountered, as they are in every phase of chemical engineering, special techniques are required, particularly in mixing, materials handling, pumping and filtering. It is the purpose of this paper to discuss some of the special problems of viscous materials, and take note of some of the types of equipment which have been applied successfully in their processing.

Water has for some time been taken as the standard of viscosity comparisons. Units of viscosity are based upon specific conditions of energy requirements for the mass movement of material. Viscosity may be looked upon as internal mass or molecular friction, and it may be expressed quantitatively in terms of the force required to distort or move a portion of the mass with respect to the remainder of the material. The force for such movement is essentially one of shear and viscous masses must experience a series of shearing effects among the molecular aggregates, miscelles or particles before a change of shape or an intramass movement can take place.

Measurement of Viscosity

Considerable study has been devoted to single-component liquids, and the laws governing their movement have been formulated. In multiphase systems consisting of mixtures of liquids and solids, viscosity values usually have to be determined by one of the various instruments employed for such determinations. Readings from one type of instrument can be transposed into those of another, although certain sorts of viscous material show some variation. In calculating viscosity in absolute units (poises or centipoises) we recognize the relationship $\mu = fs/v$, where μ is the viscosity in poises; f is the applied force in dynes; v is the relative velocity in centimeters per second of two moving planes in the fluid, each of 1 sq. cm. in area; and s is their distance apart, in centimeters. Obviously, in making a viscosity determination on a mixture, the mixing operation should be completed and a fairly homogeneous mass obtained before the measurement is attempted.

Viscosity in pure liquids is an inherent property of the material, the nature and laws of which we do not understand thoroughly. It has been observed, however, that there are certain conditions in the molecule that have a dominating effect on the viscosity. The term fluidity is used to designate the reciprocal of viscosity. An *elastic* mass is one which regains its original contour, or nearly so, on removal of the deforming force. A *plastic* material, however, retains a certain degree of set after deformation. Although the term plasticity is usually applied to materials having very high viscosity values, its technical application is to that property of materials which is responsible for their resistance to initial deformation under the application of a force. Thus a truly viscous material will start to flow under the smallest application of a force, while a truly plastic material will not deform until a certain magnitude of the force has been reached, after which its flow is much like that of a viscous material. Clay and putty are representative of plastic masses, while rubber and gelatine are examples of elastic bodies. All plastic masses exhibit some elasticity, and all elastic materials possess some plasticity.

To a limited extent it is possible to generalize about the viscous properties of liquids. For example, liquids of high molecular weight are usually more viscous than the same type of substance of low molecular weight. This condition is more apparent with organic than inorganic products. Further, long straight-chain compounds are more viscous than cyclic compounds of the same molecular weight. In addition, we have observed that viscosity increases with an increase in the number of hydroxyl groups in a straight carbon chain as, for example, methanol to glycerol to sorbitol, and oleic acid to ricinoleic acid. In antithesis, we observe that an oxygen atom in an ether, ketone or aldehyde linkage results in a product of substantially lower viscosity, such as ethyl ether, acetone and acetaldehyde, which are of lower viscosity than water. A viscous mass may be made up of one or more phases of miscible and immiscible liquids and of liquids and solids.

How to Mix Plastics

The initial handling of a viscous material usually includes a mixing operation. With materials of high viscosity (so-called plastics), the single-impeller type of agitator is usually valueless, the plastic moving as a unit mass even when the impeller is placed eccentrically, so that no mixing of consequence results. The pre-

Based on a paper presented by the author on Mar. 24, 1939, before a joint meeting of the Louisiana and Mississippi sections of the American Institute of Chemical Engineers, and the Tulane University student chapter of the Institute, at Tulane University, New Orleans, La.

ferred types are kneading machines with two blades operated at different speeds, pug mills, banbury mixers, crutchers and the like. The effectiveness of the mixing operation is usually measured by the time required for a small portion of dyestuff to color the entire mass. The mixing operation for very viscous masses requires considerable energy, exceeding 1 hp. per 5 gal. of plastic being mixed. Among such materials are doughs, cellulose plastics, putties, asphalt compositions, resins plastics and the like. Rubber and elastic products are mixed by continued folding and passage through rolls or banbury type mixers.

Technique of Transfer

The transfer or conveyance of plastic masses frequently involves more difficult operations than are experienced in mixing. Plastics may be conveyed by means of belt or screw conveyors, or if sufficiently fluid, by means of an adequate piping system. For those non-sticky plastics which do not wet the wall and which move en masse, the prerequisites for movement in pipes are increasing diameters with higher viscosities, long radius elbows, oversize plug-type valves and smooth bore.

A somewhat different situation is encountered with the sticky type which forms a film or lamination adjacent to the inner surface of the wall. For belt conveyance the plastic is carried as though it were a solid, and as no internal shearing is involved, no energy problem prevails. However, in addition to being sticky, such materials usually tend to pack, as well. Either the type of belt material must be given consideration or a suitable separate and removable covering may be used. Sometimes the belt surface may be wet with a solvent or some other liquid, or it may be powdered to permit ready removal of the plastic material. Prevention of packing may be effected by operating in a tunnel at low temperatures, by intermittent loading of the belt, or by dusting the mass with powder.

Some of these tactics are also used in screw conveyors. In a screw conveyor system we effect the mixing operation while the product is being transported, but such mixing is not as effective and thorough as when conducted in a unit specifically designed for the mixing operation. Screw conveyors are large consumers of power, as much internal shearing is involved as well as surface friction on the walls of the conveyor trough and the faces of the helical screw.

The transference of plastics in piping systems involves the use of either a positive type of pump or compressed air or equivalent gas. Various types of pump may be used, including the single or multiple screw, eccentric vane, twin gear, and reciprocating piston types. With very viscous plastics containing volatile solvents, none of these types can be kept primed, since the development of a suction head merely evaporates a portion of the contained solvent, resulting in failure to maintain a continuous feed by this means. It becomes necessary, therefore, to keep the pump primed by effecting a substantial gravity pressure head, or an equivalent head by means of compressed air or other gas.

Care must be exercised in the choice of compressed gases for moving plastic masses. Air or gases which form flammable mixtures with the vapors of volatile solvents used in the plastics must be avoided. Here carbon dioxide, nitrogen, or some other inert gas may be mixed with the compressed air so as to inhibit the formation of an explosive mixture under the conditions of operation.

In addition, information must be obtained as to the solubility of the compressed gas in the components of the plastic mixture. If the compressed gas is soluble to a considerable extent in one or more components of the plastic mass, difficulty will be experienced initially in building up sufficient pressure of the gas to move the plastic. Later, in subsequent processing which usually develops a rise in the temperature of the mass, the dissolved gas will be released, thus tending to form bubbles or foam and a spongy structure.

Problems in Filtration

One of the most difficult tasks involved in the engineering of viscous materials is filtration. The physical nature of the material precludes all types of separations except extrusion through a screen. The pressure required is a function of the viscosity value of the masses to be filtered through a given screen, and as in other filtering operations, rises rapidly as the openings in the screen become clogged. Filter aids are useful, but careful study is needed in their selection. Many plastics form into gel-like lumps that build into an almost impervious matte on a filter screen and can be moved through only at destructively high pressure. The particles that are forced through are substantially larger than the screen openings and, on account of their elastic nature, expand to almost their former volume after passage through the screen.

To prevent dense matte formation filter aids made up of granulations as large as a grain of rice are sometimes used. One filtering operation is using granulated zinc, similar to that used in the laboratory, to prevent dense gel matte formation. From the above it is obviously the preferred procedure to use the lowest pressure which will move the plastic at a satisfactory rate. When the pressure must be increased to abnormally high values in order to achieve this flow, it then becomes necessary to clean the filter.

How Plastics Are Used

Many plastic masses are used as such. Among them are putties, paints, modeling clays, tooth pastes, cements and adhesives, and the like. Many less viscous products such as emulsions, cosmetic preparations, foods, lubricants, etc., are almost invariably used in the form produced. Other plastic products, however, involve a final processing before they are usable by the consumer. These operations include shaping and some treatment which will render the product able to retain that shape. This condition is achieved by the removal of volatile solvents or the liquid phases; by the thermal setting or heat polymerizing or condensing of resin plastics; by precipitation or coagulation; and by other chemical reactions which change the physical nature of the mass.

Operations for shaping plastic products may be illustrated by compression and injection molding; film and sheet extrusion and casting; filament extrusion and chemical conversion; soap and ice flake production; die casting of alloys; blowing and casting of glass; and a multitude of related operations. As discussed above the shaping operation often requires the action of a pump or compressed gas to move the plastic in the extrusion or molding operation. The plastic is usually heated, which results in a great reduction in its viscosity. Then, as the mold cools, the ultimate form of the object is attained. The ease and speed of such operations, the excellent surface, the permanence and toughness of the material, and the relative low cost of objects so made, have been responsible for the fact that the era we are now entering has accurately been called "The Plastic Age."

Chemical Engineer's BOOKSHELF

New Titles, Editions and Authors

PRACTICAL MATHEMATICS

APPLIED MATHEMATICS IN CHEMICAL ENGINEERING. By *Thomas K. Sherwood* and *Charles E. Reed.* Published by McGraw-Hill Book Co., Inc., New York, N. Y. 1939, 403 pages. Price $4.

Reviewed by *H. F. Johnstone*

MODERN CHEMICAL ENGINEERING requires considerable ability in mathematical analysis. It is recognized that the usual undergraduate courses in mathematics supply insufficient training in this method of rationalization. Attention is mostly given in these courses to the formal methods of the differential and integral calculus and to the classification and solution of types of differential equations. The equally important experience in visualizing the physical laws in their differential forms, so that a problem may be expressed in mathematical language, is one in which engineers are often lacking. Formal solution of the differential equations from a complicated process may be difficult, or even impossible, but once an insight into their meaning is gained, the less formal numerical methods may be used, or short cuts taken, the results of which are rich in their implications. The extensive developments in the quantitative insight into the unit operations and the application of the laws of kinetics of reactions to continuous processes has made a book on applied mathematics for chemical engineers particularly desirable.

The authors have presented the subject from a well balanced viewpoint which should prove helpful to the student as well as to those who wish to refresh themselves on principles learned in earlier years. Much space is devoted to the physical significance of mathematical processes. Facility in setting up differential equations is achieved by studying practical examples. The formal methods of solving ordinary differential equations are first presented. These are followed by an excellent treatment of graphical and numerical methods.

Partial differentiation is treated with special reference to the application to thermodynamics. The use of infinite series in the solution of ordinary and partial differential equations is discussed. The treatment of Fourier series and Bessel functions is presented in as simple and practical a manner as possible. The methods of fitting empirical equations to data and of numerical integration, interpolation and differentiation are of interest to those who deal with numerical data. A chapter on the many valuable graphical methods finding widespread use in chemical engineering design work and a section on alignment charts are also presented in excellent manner. The final chapter discusses the theory of errors and precision of measurements. To satisfy those who like their problems unsolved an appendix with thirty-seven examples is included.

A unique feature of the book is the many illustrative problems which are made an integral part of the text. This arrangement undoubtedly helps to maintain the reader's interest. Because of the variety of problems discussed, the book may be regarded as a treatment of chemical engineering as well as mathematics, although the arrangement of subject matter is based on the latter.

While written by chemical engineers for engineers, teachers of mathematics themselves will find much of value in the practical presentation. Only in a few minor instances could there be any criticism of insufficient presentation of proofs for mathematical processes. There is little doubt that chemists and chemical engineers will welcome this thoroughly modern treatment of mathematical techniques.

COLLOIDS

COLLOIDAL PHENOMENA. By *Dr. Ernst A. Hauser.* Published by McGraw-Hill Book Co., New York, N. Y. 294 pages. Price $3.

Reviewed by *C. S. Fuller*

PERHAPS IN NO OTHER BRANCH of chemistry is there greater need for precise description of terms than in colloid chemistry. The industrial scientist or the student undertaking the study of colloids for the first time often finds the terminology which has grown up a hindrance rather than a help to a clear understanding of the subject. In his book Dr. Hauser has recognized this need and has given clear and concise descriptions of the numerous and complicated phenomena encountered in colloidal systems.

The object of the book, to serve as a "guide to some of our recent viewpoints" rather than as a "complete treatise on colloids," is further aided by the omission of mathematical treatment wherever possible. This aspect of the subject is not neglected, however, since a full appendix of 46 pages treats briefly of the mathematical relationships frequently employed in the science. The appendix also offers an admirable résumé of the various techniques used in investigating colloidal systems. The author has succeeded in keeping the reader aware of the reality of the subject of colloids by frequent reference to pertinent literature and by introducing in appropriate fashion the names of those responsible for major advances in the subject. For those who wish to acquaint themselves quickly with the essentials of colloid chemistry, "Colloidal Phenomena" can be highly recommended.

ENGLISH DEVELOPMENTS

BRITISH CHEMICAL INDUSTRY: ITS RISE AND DEVELOPMENT. By *Sir Gilbert T. Mortan* and *David Doig Pratt.* Published by Longmans, Green & Co., New York, N. Y. 387 pages. Price $6.25.

ARISING OUT OF THE BRITISH Chemical Research Laboratories at Teddington and written by two of Britain's ablest scientists, one might expect this book to be a highly technical and perhaps slightly academic history of industrial chemistry in Great Britain. Instead it is an intensely practical account of the development of the various chemical industries there, with emphasis on the principal processes and equipment. It is abundantly illustrated with almost 100 drawings and diagrams and more than 30 excellent plates, each of which reproduces several interesting industrial scenes. A detailed index adds greatly to the reference

value of this book. American chemical engineers, especially those with historical leanings, will find this book most interesting for its comparisons of British and American progress.

ELECTROCHEMISTRY

THE PRINCIPLES OF ELECTROCHEMISTRY. By *Duncan A. MacInnes*. 478 pages; 150 illustrations. Published by Reinhold Publishing Corp., New York, N. Y.

Reviewed by *Colin G. Fink*

IN THE PREFACE the author emphasizes that the "subject of electrochemistry has become so extended" that it is necessary to "severely limit the range of topics considered."

Accordingly, the author has confined himself to the principles of electrochemistry of aqueous solutions, in particular, very dilute solutions. His treatment of these has been most thorough and is based on many years of careful application to the subject. Among the twenty-four chapter headings are included the laws of Faraday, Electrolytic Conductance, Electrolytic Transference, the Principles of Thermodynamics, the Debye-Hückel Theory, Concentration Cells, Standard Electrode Potentials, Determination of pH, Electrometric Titrations, the Dielectric Constants of Liquids, Electrokinetic Phenomena and Passivity and Overvoltage.

Most of the experimental data referred to in the book are of relatively recent origin, obtained during the last 10 or 15 years.

To all interested in the physical chemistry of solutions this book is highly recommended.

THEORETICAL AND APPLIED ELECTROCHEMISTRY. By *Maurice de Kay Thompson*. Published by The Macmillan Co., New York, N. Y. 535 pages. Price $5.

Reviewed by *F. J. Kohlins*

THIS SINGLE VOLUME aims to give an account of the most important electrochemical industries, as well as the principal applications of electrochemistry in the laboratory. Both the theoretical and technical points of view are discussed and numerous references to the literature of each are cited.

While the book purports to be a textbook, its contents presuppose a greater knowledge in the fields of chemistry, physics and physical chemistry than the ordinary student would possess. The material contained in the book should be of value to the worker in this field since the author fills the book with practical industrial applications.

The book is divided into three parts. The first deals with the theories of electrochemistry including electrokinetic phenomena, electrolysis and polarization. The second part is the applied chemistry of aqueous solutions and includes electroplating, refining of metals and the electrolytic purification of water, to mention only a few of the many applications given. And, finally, in the third part we have complete theoretical and technical data on electric furnaces and their products, electrothermic metallurgy and the fixation of atmospheric nitrogen.

The main value of this book seems to lie in the fact that it is the first time that an author has attempted to correlate in one volume all the theoretical and practical applications of the vast field of electrochemistry and has succeeded in so doing with a fair degree of completeness in only a little over five hundred pages. The book should prove a time saver to many who previously had to search through all of the original sources adequately quoted and correlated in "Theoretical and Applied Electrochemistry."

In the preface the author acknowledges his indebtedness to various individuals and companies including the principal chemical, engineering and electrochemical societies, a score of large industrial companies, many consulting engineers and various departments of the Federal government, all experts in their particular phases of electrochemistry.

THE ELECTROCHEMISTRY OF GASES AND OTHER DIELECTRICS. By *G. Glockler* and *S. C. Lind*. Published by John Wiley & Sons, Inc., New York, N. Y., and Chapman & Hall, Ltd, London. 469 pages. Price $6.

Reviewed by *C. L. Mantell*

"THE WIDELY SCATTERED and voluminous material on the physical and chemical behavior of gases in the electric field," with the addition of the generally accepted theoretical aspects is collected and digested in this volume.

The volume deals with chemical reaction in the glow and silent electrical discharge, the corona, the arc and the electrodeless discharge. The chemical effects of cathode rays, the reactions caused by electrons of known speed, and the formation of atoms and radicals in discharge tubes constitute the first part of the volume.

The second part deals with chemical reactions in electrical discharges with chapters devoted to hydrogen and the hydrocarbons; the hydrogen-carbon compounds containing other elements; the carbon compounds with nitrogen, oxygen, sulphur, and the halogens and the corresponding nitrogen compounds with these elements. Active nitrogen is set aside in a large chapter, while ozone and oxygen are exhaustively treated.

The third part of the book covers the physical and theoretical aspects of discharge reactions with chapters devoted to electron affinity of atoms and molecules, ionic mobility, the production of ions, the mechanism of ionization, cathode sputtering of metals, and gas disappearance in discharge tubes, with a concluding chapter on the mechanism of chemical reactions in electrical discharges.

The authors are to be congratulated upon the exhaustive treatment given the individual topics, coupled with a wealth of literature references, handled in a critical manner. The authors themselves have contributed to the literature of the subject in a very large measure. There is no difficulty for this reviewer in agreeing with the foreword by Professor Karapetoff, that "the book should prove invaluable to those who need the factual material on the chemical behavior of gases in an electric field; this includes the workers on the theoretical aspects of conduction and ionization, for whom it will serve as a convenient compendium of references and data on the subject."

CULTURAL ENGINEERING

IN A BLUE MOON. By *Nell Dorr*. Published by G. P. Putnam's Sons, New York, N. Y. 70 plates, 80 pages. Price $3.50

Reviewed by *S. D. Kirkpatrick*

AMONG *Chem & Met.* readers even the connoisseurs of photographic art (of which, doubtless, there are many) may not have linked the name of Nell Dorr with that of a well-known chemical and metallurgical engineer. Examples of Mrs. Dorr's remarkable skill have appeared recently in *Coronet* and certain other publications that might possibly have escaped the attention of many chemical engineers. But for those who have a genuine appreciation of what can be caught and preserved in the "little black box" of a true artist, this collection of her pictures of "three little girls," taken on the Florida Keys in 1929, will prove more humanly interesting than the erudite writings of her distinguished husband.

HYDROCARBON DATA

PHYSICAL CONSTANTS OF HYDROCARBONS. Volume I. Paraffins, Olefins, Acetylenes and other Aliphatic Hydrocarbons. By *Gustav Egloff*. Published by Rheinhold Publishing Corp., New York, N. Y. 403 pages. Price $9.

Reviewed by *J. H. Boyd, Jr.*

THE AMERICAN CHEMICAL SOCIETY series of monographs brings out this first volume of a most ambitious compilation of the physical constants of hydrocarbons. The author, Dr. Gustav Egloff, of the Universal Oil Products Co., has an established reputation in the hydrocarbon field.

This first volume deals with the aliphatic hydrocarbons, succeeding volumes will cover the cycloparaffins, cyclo-olefins and cyclo-acetylenes, the aromatics and more complex ring systems, while the last volume will correlate physical properties and chemical structure. The potential utility of the completed work will obviously

be great both because of the data and references on individual hydrocarbons and for the prospective correlations permitting a check on the accuracy of existing data as well as the prediction of the physical properties of hydrocarbons yet unknown. The physical properties reported are limited to the melting and boiling points, specific gravities and indexes of refraction. In this respect the book may be of somewhat less immediate value than a similar but less extensive compilation of M. P. Doss, recently reviewed here, which gives other properties of engineering value as well. However, Dr. Egloff's introduction promises more than to make good this deficiency through future reports on studies now in progress. The introduction to the present work is particularly helpful in its clear and complete description of the scheme of organization of the data and the review of the Geneva system of nomenclature for hydrocarbons. The limitations of the data and of the methods of interpolation are treated fully. However, data on each series are not available continuously to the highest member and become spottier with the unsaturates.

NEW DATA ON SOLVENTS

THE TECHNOLOGY OF SOLVENTS. By *O. Jordan*. Translated by *A. D. Whitehead*. Distributed by Chemical Publishing Co., New York, N. Y. 301 pages. Price $10.

Reviewed by *W. L. Abramowitz*

IN THE LAST TEN YEARS the variety and uses of solvents have attained such complexity that a new comprehensive summary is of definite interest. Those who are familiar with Durran's "Solvents" will find the present volume a greatly amplified counterpart. Jordan has a wide reputation in Germany as an authority on solvents and has incorporated in his book many of the more recent developments in that country.

The mechanism of solvent action is first discussed with emphasis on the effect of polar and non-polar molecular forces. Workers in the field of lacquers will find the section on rates of evaporation and the physical properties of solvents and solvent mixtures of particular value. The most important chapters of the book are centered on the solvents for cellulose derivatives, resins, rubber, and on plasticizers. Diluents and dilution ratios, graphical methods of solvent balance and the selection of solvents to avoid blushes and film defects are considered. The chapter on plasticizers is particularly good.

Some little space is devoted to use of solvents for extraction purposes and the different methods for the recovery of solvents. Approximately half of the book is given over to a listing of individual solvents and plasticizers with their properties and limitations and is quite complete and up to date. A number of useful tables are given at the end including charts on physical data and azeotropic mixtures, solvent compatibilities with resins, rubber and dyestuffs.

GLASS DATA

PROPERTIES OF GLASS. By *George W. Morey*. Published by Reinhold Publishing Corp., New York, N. Y., 1938. 561 pages. Price $12.50.

Reviewed by *C. W. Parmelee*

GEORGE W. MOREY'S recently published book on the properties of glass gives an authoritative, readable and critical survey of our knowledge of this topic. Few persons are equally well equipped for the task.

Dr. Morey's book contains only a few casual references to manufacturing operations or processes. The Chapter on the History and Definition introduces the reader to the subject and then follow equally lucid discussions of the topics: Devitrification, Composition, Durability, Viscosity, Annealing, Surface Tension, Heat Capacity, Heat Conductivity, Density, Coefficient of Expansion, Elastic Properties, Strength, Thermal Endurance, Hardness, Optical Properties, Electrical Properties, Magnetic Properties, and the Constitution of Glass.

The present quarter-century will always be notable in glass technology because of the very great industrial development associated with a correspondingly great research activity. The journal literature published on this field has also increased at a correspondingly rapid pace. Dr. Morey's valuable text makes available to the American and English workers the wealth of accumulated knowledge in this extremely interesting and important field. Scholars in other countries will be envious of this invaluable tool.

CELLULOSE

AN INTRODUCTION TO THE CHEMISTRY OF CELLULOSE. By *J. T. Marsh* and *F. C. Wood*. Published by D. Van Nostrand Co., New York, N. Y. 1939, 431 pages. Price $7.50.

Reviewed by *Edwin C. Jahn*

A MODERN CORRELATION in English of the advances of recent years in the chemistry and technology of cellulose, this book, to a large extent, satisfies an important need. The book is divided into five parts. Part one discusses the occurrence and distribution of cotton, flax and ramie cellulose, the purification of cotton, and the colloidal, physical and other general properties of cellulose. Part two is concerned with the dispersion of cellulose by various reagents, with particular emphasis on hygroscopic substances, cuprammonium hydrate and its application to viscosity measurements and rayon making, strong alkalies and the properties of mercerized cellulose. Part three deals with the modification of cellulose by acids and oxidizing agents.

Of particular note is the large amount of space devoted to Part Four covering the derivatives of cellulose. The authors include most of the cellulose esters and ethers which have been described in the literature as well as amino-cellulose, soda cellulose and cellulose xanthate. Part Five includes an interesting survey of the work done on the molecular weight of cellulose with special reference to Standinger's viscosity studies, a discussion of the chain molecule hypothesis and the present concept of the molecular structure of cellulose.

The book is written primarily with the textile and cellulose derivatives industries in mind. However, the subject is presented on a fundamental basis and includes many practical applications so that it should be a useful guide and reference book to all interested in cellulose chemistry. There are numerous references in the text to the literature, including 321 patents.

HEAT TREATMENT

STEEL AND ITS HEAT TREATMENT. By *D. K. Bullens* and the Metallurgical Staff of the *Battelle Memorial Institute*. Fourth edition. Volume II. Published by John Wiley & Sons, Inc., New York, N. Y. 495 pages. Price $5.

Reviewed by *Edward S. Johnson*

VOLUME I DEALT almost entirely with the fundamentals involved in the heat treatment of steels, while volume II discusses largely the practical applications. In view of the fact that the various alloy steels are composed of 15 or more chemical elements, naturally many modifications in heat treatment must be applied and the permutations are myriad. The carbon steels, containing innumerable elements are given extensive treatment, the ultimate goal being to attain certain tensile and yield strengths, elongation, hardenability, machinability, toughness, resistance to impact and corrosion. A copious bibliography accompanies the text rendering the whole book a complete manual on the art of heat treatment.

INTRODUCTION TO THE STUDY OF HEAT TREATMENT OF METALLURGICAL PRODUCTS. By *Albert Portevin*. Published by The Penton Publishing Co., Cleveland, Ohio. 246 pages. Price $5.

TO PRESENT THE FUNDAMENTALS and the essential principles concerning the thermal treatments of steel in a simple manner, Albert Portevin has made an attempt in his book to deal mainly with the experimental determinations and facts resulting from observation.

Subjects treated by the author include transformation points of steel, preliminary treatment of steel, quenching, hardened steels, hardening capacity of steel, tempering, classification of industrial steels, annealing, malleabilization of cast irons, heat treatment of light aluminum alloys, etc.

The aim of the author has been to in-

clude ideas and directions to interpret and understand the phenomena and solve the difficulties which actually occur in the heat treatment of various materials of construction. Research engineers, metallurgical students and steel plant engineers, as well as others engaged in the investigation of the heat treatment of ferrous and nonferrous metals will find this a very useful text.

RECENT BOOKS and PAMPHLETS

A Survey of Sulphur Dioxide Pollution in Chicago and Vicinity. By Alamjit D. Singh. Circular No. 36, published by the University of Illinois, Urbana, Ill. 32 pages. Results of an investigation show that the high volatile, high sulphur coal of the Middle West can produce damaging concentrations of SO_2 in an atmosphere such as that of Chicago. The author points to possible means of SO_2 abatement by chemical treatment and he cites successful experience with this method in England.

Routine Sampling for Control of Atmospheric Impurities, Bulletin of Preventive Engineering Committee of the Air Hygiene Foundation and Headed by Philip Drinker of Harvard. Price 50c. The Bulletin lists proved methods of collection, determination and apparatus for checking 45 dangerous substances found in industrial atmospheres. Samples should be taken wherever men work and the air checked first, by measuring air currents, and, second, by estimating impurities. The bulletin goes into exhaustive detail on all types of atmospheric impurities as well as numerous methods of dealing with them.

Power Laundries, Cleaning and Dyeing Establishments in Canada, 1937. Department of Trade and Commerce, Dominion Bureau of Statistics, Internal Trade Branch, Ottawa, Canada. 42 pages, 25 cents. Statistics and lists of laundries and cleaners and dyers operating in Canada, 1937. (Now included in Census of Service Establishments rather than Census of Manufacturing Industries.)

American Gas Association Proceedings, 1938. Published by American Gas Association, 420 Lexington Ave., New York, N. Y. 844 pages. Price, $3 to members, $7 to non-members. This annual volume represents the most complete survey of new technical literature bearing on manufacturing and industrial utilization of gas. Any library desiring to give good service on fuels must contain this series of Annual Proceedings.

Industrial Research Laboratories of the United States, Including Consulting Research Laboratories (Sixth Edition). Bulletin No. 102, National Research Council. 270 pages. Price, $2.50 (paper); $3 (cloth). A directory of research laboratories, listing the men in charge, size of the staff, and the principal activities of each laboratory. Also includes a subject index to research activities.

Standards of the Heat Exchange Institute-Condenser Section. Second Edition. Published by Heat Exchange Institute, New York, N. Y. 1939. $1. This 38 page pamphlet consists of two parts, the first dealing with standards for surface condensers, and the second, standards for barometric and low level jet condensers. Several useful engineering charts and data tables are included. Typical of the information given is that relating to condenser performance, cooling water requirements and the properties of air-water vapor mixtures.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

Silicosis and Lead Poisoning Among Pottery Workers, by Robert H. Flinn and others. Public Health Service, Bulletin No. 244; 30 cents.

Silicosis and Similar Dust Diseases—Medical Aspects and Control, by R. R. Sayers and R. R. Jones. Public Health Service, Reprint No. 1974; 5 cents.

Limits of Inflammability of Gases and Vapors, by H. F. Coward and G. W. Jones. Bureau of Mines, Bulletin 279 (Revised Edition); 20 cents.

Methods of Analyzing Coal and Coke, by F. M. Stanton, A. C. Fieldner, and W. A. Selvig. Bureau of Mines, Technical Paper 8 (1938 Edition); 15 cents.

Preprints of chapters from Minerals Yearbook 1939 are now beginning to appear. Those issued thus far are: Asbestos; Chromite; Minor Metals; 5 cents each.

Gypsum and Anhydrite, by Forrest T. Moyer. Bureau of Mines, Information Circular 7049; mimeographed.

Lithium, by Frank L. Hess. Bureau of Mines, Information Circular 7054; mimeographed.

Flotation of Southern Illinois Lead-Zinc-Fluorspar Ores, by J. B. Clemmer, W. E. Duncan, F. D. DeVaney, and M. Guggenheim. Bureau of Mines, Report of Investigations 3437; mimeographed.

Recovery of Potassium Sulphate and Alumina from Alunite by Fusion with Boric Acid, by J. Koster, R. G. Knickerbocker, A. L. Fox, and P. R. Perry. Bureau of Mines, Report of Investigations 3438; mimeographed.

Volumetric Determination of Molybdenum, by C. E. Arrington and A. C. Rice. Bureau of Mines, Report of Investigations 3441; mimeographed.

Marketing of Salt, by F. E. Harris. Bureau of Mines, Information Circular 7062; mimeographed.

Explosion and Fire Hazards of Combustible Anesthetics, by G. W. Jones. Bureau of Mines, Report of Investigations 3443; mimeographed.

Tin Deposits of the Black Hills, South Dakota, by E. D. Gardner. Bureau of Mines, Information Circular 7069; mimeographed.

Synthetic Organic Chemicals. U. S. Tariff Commission preliminary statistics of United States production and sales in 1938; mimeographed.

Water Pollution in the United States. Third Report of the Special Advisory Committee on Water Pollution, House Document No. 155, 76th Congress, 1st Session; 25 cents.

Brick and Tile, by Miriam E. West. Works Progress Administration, National Research Project Report No. N-2. Available only from Works Progress Administration, 1734 New York Ave., N. W., Washington, D. C.

List of Available Publications of the U. S. Department of Agriculture, January 2, 1939. U. S. Department of Agriculture, Miscellaneous Publication No. 60; printed.

1938-39 Annual Naval Stores Report. Gives production, distribution, consumption and stocks of turpentine and rosin of the United States by crop years. U. S. Department of Agriculture, Bureau of Chemistry and Soils; mimeographed.

The Use of Chemicals in Forest Fire Control, by T. R. Truax. Available only from Forest Products Laboratory, Madison, Wis.; mimeographed.

Chemistry of the Alkaline Wood Pulp Process, by Sidney L. Schwartz and Mark W. Bray. Available only from Forest Products Laboratory, Madison, Wis.; mimeographed.

Microscopic Methods Used in Identifying Commercial Fibers, by Thora M. Plitt. National Bureau of Standards, Circular 423; 10 cents.

Compilation of Data on United States Trade with Germany. U. S. Tariff Commission; processed.

Statistics on Sugar. U. S. Tariff Commission; mimeographed.

Physical Properties of Synthetic Resin Materials, by Meyer Fishbein. National Advisory Committee for Aeronautics, Technical Notes No. 694; mimeographed.

Statistical Abstract of the United States 1938. Bureau of the Census; $1.50 (Buckram).

Foreign Commerce & Navigation of the United States, 1937. Bureau of Foreign & Domestic Commerce; $2.25 (Buckram).

Consumer Market Data Handbook, 1939 Edition, by Ben P. Haynes and Guerry R. Smith. Bureau of Foreign and Domestic Commerce, Domestic Commerce Series No. 102; $1.75.

Federal Specifications. Drums and Pails; Steel, I. C. C. Type 5E, 5-Gallon, Single-Trip-Container, RR-D-761; Soda; Caustic (Lye): (For) Cleaning Purposes, P-S-631 Amendment -3; Mineral-Wool, Impregnated; Blanket, Block, and Pipe-Covering (Molded), (For Low Temperatures), HH-M-371; 5 cents each.

Imports Under Reciprocal Trade Agreements by Countries, 1937 and 1938. Thus far this series of statistics issued by the U. S. Tariff Commission has covered the following countries: Switzerland, Belgium, Netherlands, France, Sweden, and Brazil. Others will be released shortly. Available only from U. S. Tariff Commission; processed.

Report Upon Certain Deficient Strategic Minerals, by the staffs of the Geological Survey and the Bureau of Mines. Bureau of Mines unnumbered document, dated February 28, 1939.

Crushed-Stone Industry, by Harry S. Kantor and Geoffrey A. Saeger. Works Progress Administration, National Research Project Report No. E-8. Available only from Works Progress Administration, 1734 New York Avenue, N. W., Washington, D. C.

Annual Report on Tobacco Statistics, 1938. U. S. Department of Agriculture, Statistical Bulletin No. 67; 15 cents.

Some Asphalts from Oregon Basin (Wyoming) Crude Oil, by K. E. Stanfield. Bureau of Mines, Report of Investigations 3435; mimeographed.

Indentation and Recovery of Low-Cost Floor Coverings, by P. A. Sigler and Myrtle H. Woodward. National Bureau of Standards, Building Materials and Structures Report 14; 10 cents.

Sound Insulation of Wall and Floor Construction, by V. L. Chrisler. National Bureau of Standards, Building Materials and Structures Report 17; 10 cents.

Nomographic Chart for Temperature Correction of Hydrochloric Acid Densities

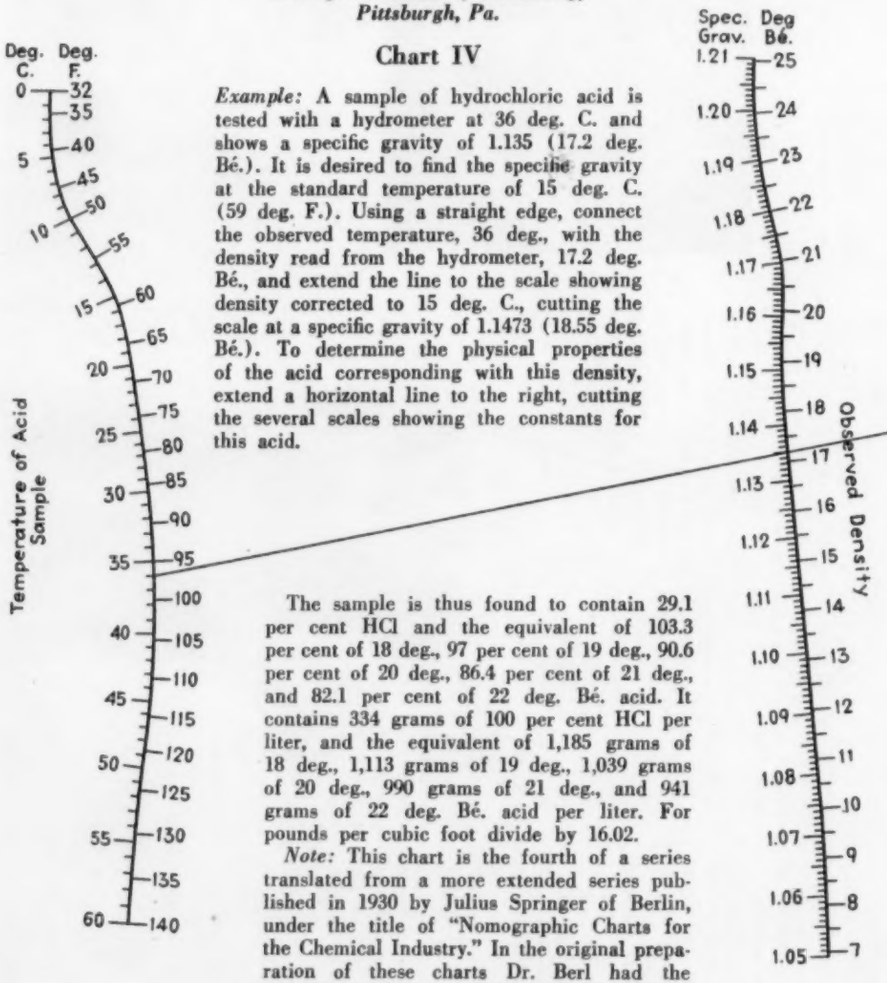
Nomographic Chart for Temperature Correction of Hydrochloric Acid Densities

With Supplemental Scales for the Interconversion of Physical Data

By ERNST BERL
Research Professor
Carnegie Institute of Technology
Pittsburgh, Pa.

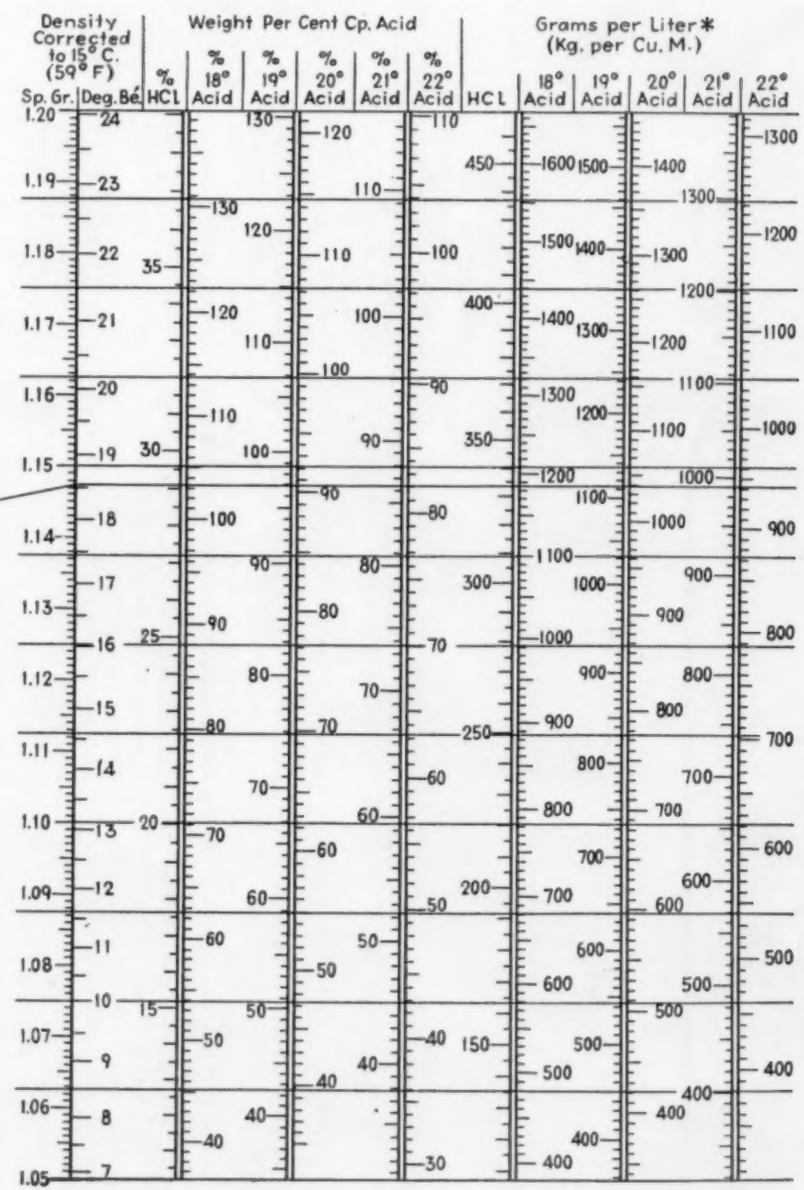
Chart IV

Example: A sample of hydrochloric acid is tested with a hydrometer at 36 deg. C. and shows a specific gravity of 1.135 (17.2 deg. Bé.). It is desired to find the specific gravity at the standard temperature of 15 deg. C. (59 deg. F.). Using a straight edge, connect the observed temperature, 36 deg., with the density read from the hydrometer, 17.2 deg. Bé., and extend the line to the scale showing density corrected to 15 deg. C., cutting the scale at a specific gravity of 1.1473 (18.55 deg. Bé.). To determine the physical properties of the acid corresponding with this density, extend a horizontal line to the right, cutting the several scales showing the constants for this acid.



The sample is thus found to contain 29.1 per cent HCl and the equivalent of 103.3 per cent of 18 deg., 97 per cent of 19 deg., 90.6 per cent of 20 deg., 86.4 per cent of 21 deg., and 82.1 per cent of 22 deg. Bé. acid. It contains 334 grams of 100 per cent HCl per liter, and the equivalent of 1,185 grams of 18 deg., 1,113 grams of 19 deg., 1,039 grams of 20 deg., 990 grams of 21 deg., and 941 grams of 22 deg. Bé. acid per liter. For pounds per cubic foot divide by 16.02.

Note: This chart is the fourth of a series translated from a more extended series published in 1930 by Julius Springer of Berlin, under the title of "Nomographic Charts for the Chemical Industry." In the original preparation of these charts Dr. Berl had the assistance of Drs. W. Herbert and W. Wahlig.



* For pounds per cubic foot divide by 16.02.

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Process Equipment NEWS

Machinery, Materials and Products

Combination Air Filter

A NEW DEVELOPMENT of the American Air Filter Co., Louisville, Ky., is a novel combination of electrostatic precipitator and mechanical air filter to which has been given the name of Electro-Matic air filter. In operation the front curtain of the filter acts as a pre-cleaner to remove the heavier dust particles, insects, or other coarse matter which might short circuit the electrostatic precipitator. Fine dust particles which escape the front curtain pass through the ionizing unit in the center of the filter where they receive a definite electrical charge. On entering the electrostatic field of the rear curtain, these ionized dust particles are attracted to the charged plates where they are held securely in the oil film on the plates until removed in the oil bath in the bottom of the filter. The filter curtain is of a new type so designed that the accumulation of dust and dirt on the front curtain is carried directly down into the reservoir where it is removed by the cleansing action of the oil bath, leaving the rear curtain clean and freshly oiled at all times.

Grinding Mill Control

ALTHOUGH it has been in test operation for a considerable time, an official announcement has only recently been released by the Hardinge Co., York, Pa., describing the new "electric ear" method of controlling the operation of grinding mills by their sound. The electric ear consists of a cabinet and microphone which is placed near the mill. This device "listens" to the sound and controls the feeder of the mill so as to maintain a uniform sound level with a high degree of accuracy.

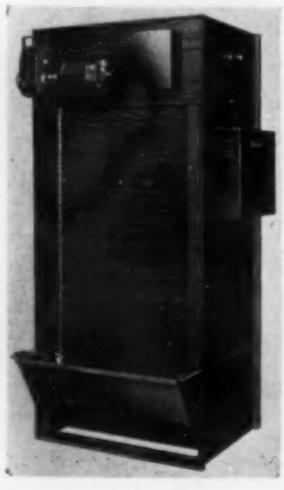
According to the manufacturer, experience has shown that no matter how uniform the feed to the mill may be, there is always irregularity due to size variation and other factors that are directly related to the noise produced by the mill. It has been found that ideal operating conditions cannot be steadily maintained by the operator's own hearing. Automatic listening by means of the electric ear, however, is stated to be far more accurate and to relieve the operator of the necessity of giving close attention to the mill. With control by this means it is stated to be possible to increase the overall efficiency of the grinding circuit by maintaining maximum capacity without danger of overloading. In addition, a far more uniform product is said to be produced.

This method of control is claimed to be responsive to the slightest change of noise level and to be suitable for either wet or dry grinding, in closed or open circuit, with standard types of classifiers. Increases in capacity generally in excess of 10 per cent are claimed. How control of the noise level accomplishes this is clearly illustrated in the accompanying chart of useful work plotted against noise level.

Pressure Fan

AN OUTSTANDING FEATURE of the new Axiflo pressure fan recently developed by B. F. Sturtevant Co., Hyde Park, Boston, Mass., is its ability to operate against wind resistance or the resistance of filters, conduits, etc. Design is such that there is stated to be no appreciable effect on air delivery of variation in wind direction or velocity, or fan location. The fan, therefore, is recommended by the maker for moving large volumes of air against resistance or for applications where space requirements call for an extremely compact unit.

Combination mechanical-electrostatic air filter



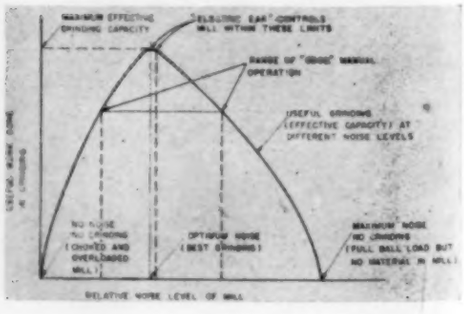
The new fan is stated to have a mechanical efficiency of 79 per cent and to operate at pressures up to 1½ in. w.g. The design combines the operation advantages of the axial flow type with the performance of the centrifugal fan. This type is available for either direct connected motor or belt drive, arranged for wall, floor, platform or ceiling installation. Eleven sizes ranging from 18 to 60 in. in diameter, with capacities up to 75,000 cu. ft. per min., are available.

Fire Extinguishing Equipment

CARDOX CORPORATION, 307 North Michigan Ave., Chicago, Ill., the concern which developed the Cardox method of mining coal through the employment of carbon dioxide, has recently announced a new line of equipment for fire extinguishment, also using carbon dioxide. The company has developed a method of

New Axiflo pressure fan

Application of noise level control to mill operation

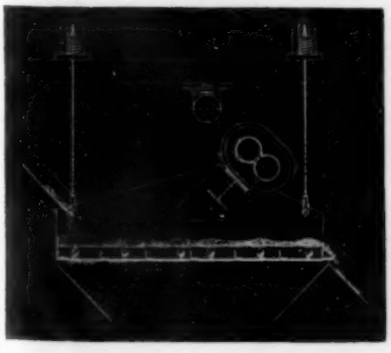

MAXIMUM EFFECTIVE GRINDING CAPACITY
RANGE OF "GOOD" MANUAL OPERATION
USEFUL GRINDING (EFFECTIVE CAPACITY) AT DIFFERENT NOISE LEVELS
OPTIMUM NOISE (BEST GRINDING)
MAXIMUM NOISE NO GRINDING (FULL BALL LOAD BUT NO MATERIAL IN MILL)
RELATIVE NOISE LEVEL OF MILL

storing and transporting carbon dioxide in liquid form at low temperatures and in unlimited bulk quantities. Equipment for the use of carbon dioxide is available in several forms, including fixed systems, completely automatic in operation; built-in systems, manually controlled; mobile equipment; and first aid extinguishers for incipient fires. Typical of the fixed installations is one using a storage tank for 7,500 lb. of carbon dioxide, capable of occupying 60,000 cu.ft. in the gaseous form and suitable for making inert a confined atmosphere of twice this volume. For the transportation of carbon dioxide to fixed equipment, the company employs trucking equipment carrying up to 16,000 lb. of carbon dioxide. For hand use, portable extinguishers in capacities of 50 lb., 10 lb. and 2½ lb. are available, the largest of which is adapted for carrying by two men or in a wheeled unit, while the smaller ones are strictly for hand operation.

Miniature rotary steam-tube dryer

Several years ago the Louisville Drying Machinery Co., Louisville, Ky., adopted the principal of building complete miniatures of each of its types of rotary drying equipment. Finding that these precise replicas reproduced results of larger machines so as to make possible prediction of full-scale results, the company decided to put several types of these miniature rotary dryers into small production. The one shown in the accompanying view was built for the Department of Chemical Engineering of Missouri State University.

Low-head non-blinding vibrating screen



Non-Blinding Screen

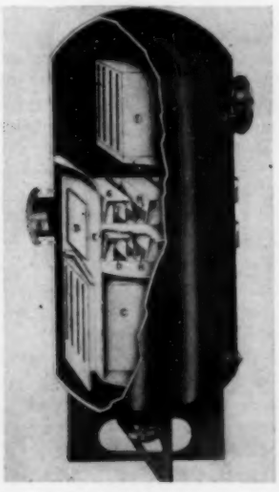
STA-KLEEN is the name of a new model of low-head vibrating screen, especially designed to keep fine-mesh screen cloth clean, which has been announced by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The new screen is stated to be particularly well adapted to the screening of moist materials. Several inches below the screen cloth is a sub-deck made of perforated metal with relatively large holes. The space between this additional deck and the screen cloth is divided into compartments, each containing a special rubber ball. When the screen is in motion the bouncing of these balls sets up a secondary vibration in the screen cloth, thus reducing blinding to a minimum without appreciable wear on the cloth, according to the manufacturer.

Improved Gas Scrubber

A RECENT ANNOUNCEMENT of the Master Separator & Valve Co., 607 South Hill St., Los Angeles, Calif., describes this company's new line of washer-scrubbers for the treatment, recovery, neutralization or washing of a variety of gases and vapors in paper mills, chemical plants and petroleum refineries. Although such equipment is specifically designed for each individual application and is not stocked in any standard types, the accompanying illustration and description will explain how one form of this equipment is constructed.

Assume a gas carrying entrained particles and a constituent which can be removed by solution in a suitable solvent. This gas enters at *A*, strikes the wearing plate at *B* and passes downward through a scrubber or entrainment removing section *C*. It then passes upward through slots *D* and emerges under the surface of the solvent through slots *H* in the bubble cap *E*. It is then passed through a second stage of bubble caps *G*. Additional bubble cap stages are provided if necessary.

Cutaway view of washer-scrubber



Finally the gas passes through another entrainment separator *I* and discharges from the apparatus. Liquid entrainment is removed at *K* and sludge at *L*. Arrangements are made for ready withdrawal and replacement of the solvent liquid, or, if desired, an alternative design employing continuous flow of the solvent may be used.

Adjustable-Stroke Pump

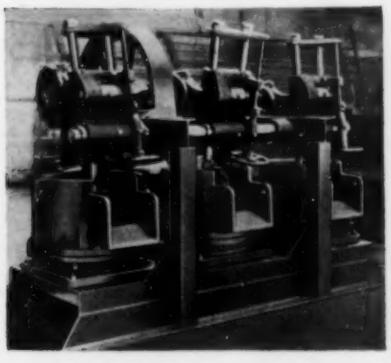
FOR LARGE CAPACITY pumping of thickener underflows, Denver Equipment Co., 1400-17th St., Denver, Colo., has developed a new heavy-duty 6-in. diaphragm pump featuring the same basic construction principles employed in this company's 2-, 3- and 4-in. adjustable stroke diaphragm pumps. The displacement of the pump is readily adjusted during operation. The pump bowl can be set to discharge in any of the four quadrants. Other features include rubber-faced valve assemblies and valves removable during operation. Bronze-bushed hinge points and babbited main bearings are used and provided with fittings for pressure lubrication.

Equipment Briefs

SPRAY ENGINEERING CO., Somerville, Mass., has developed a simple spray humidifier suitable for the humidification of spaces up to 4,000 cu.ft. in volume. The equipment consists of a compressor, storage tank for compressed air, constant level water supply tank and spray head, controlled automatically by an electrical humidistat. The equipment is claimed to maintain constant relative humidity within 1 per cent over a wide range of operating conditions, requiring only a connection to the water supply and to any standard lighting circuit.

FOR THE DETERMINATION of pH correct within 0.5 unit, R. P. Cargille, 118 Liberty St., New York City, is distributing a new set of wide-range Hydrion pH test papers which have been developed by the Micro Essential Laboratory, Brooklyn, N. Y. Five different papers are available, covering the entire pH range. Sup-

Triplex assembly of 6-in. diaphragm pumps



plied with these papers are 14 buffer solutions, one for each pH unit, used to bring out on the test paper the characteristic color for any pH unit.

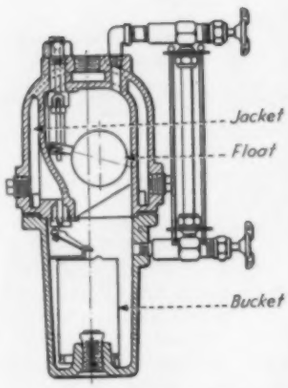
A NEW LOW-PRICED timer, known as Series 2800, Type 2803, has been introduced by the Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa. A feature of the new timer is in vernier setting which permits the time cycle to be selected accurately to within a split scale division. Four different arrangements of the load circuits are possible. The fine silver contacts carry up to 30 amp. at 110 volt a.c. and the equipment is built in various dial ranges, ranging from 0–2 to 0–60 minutes.

FOR THE USE of guards and watchmen a new type of automatic gas gun has recently been developed by J. W. Van Karner, 224 East 47th St., New York City. The gun has three barrels and employs a special clip holding three Van Karner gas cartridges, each of which contains a combination of tear, irritant and asphyxiating gas. At each trigger pull the weapon discharges a gas cartridge, effective at a range up to 20 ft. One shot is said to disable its victim for as much as 30 minutes without leaving after effects or permanent injury.

TO PROVIDE superheated steam for industrial processing, the Selas Co., 18th St. at Indiana Ave., Philadelphia, Pa., has developed a new gas-fired device which superheats the steam as used, without the necessity for steam storage. A new type of burner is employed, said to apply heat to a maximum area of the steam coil and so produce rapid transfer of heat. The burner is stated to operate efficiently and safely through a wide range of adjustment, permitting automatic maintenance of the desired steam temperature at various rates of steam demand. Units are available for operation at temperatures up to 900 deg. F., with capacities to 3,000 lb. of steam per hour.

HY-VAC WEL-VAC is the name of a new large-displacement, high-vacuum gas pump recently announced by the Sutorbilt Corp., 2008 East Slauson Ave., Los Angeles, Calif. This pump is of the two-lobe, double-impeller type with external gearing and shafts mounted on heavy duty ball bearings. No internal lubrication is required. The pump is built in seven sizes ranging in capacity from 0.22 to 8.00 cu.ft. displacement per revolution. Operating for example at 12 in. vacuum suction, and at atmospheric discharge, capacities for this range of sizes range from 116,000 to 2,100,000 cu.ft. of a typical gas per day, with power requirements ranging from 4.9 to 78.3 hp.

A RECENT ANNOUNCEMENT of the Stearns Magnetic Mfg. Co., Milwaukee, Wis., states that this concern has completed arrangements with the Exolon Co., Blasdell, N. Y., whereby the Stearns organization will manufacture and sell Exolon magnetic separators for the treatment of materials of high magnetic reluctance. The Exolon Co. also, as heretofore, will continue in the manufacture of these separators. The Exolon type separator employs a series of inductively magnetized rotors revolving in a magnetic field. The separator is so designed as to allow for increasing the number of magnetic zones to suit the material treated.

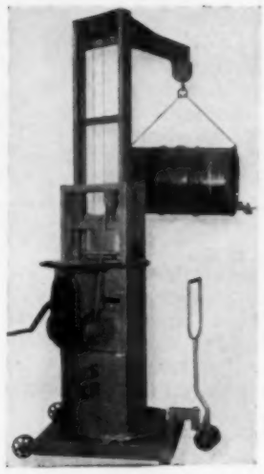


Cross section of new refrigerant gas purger

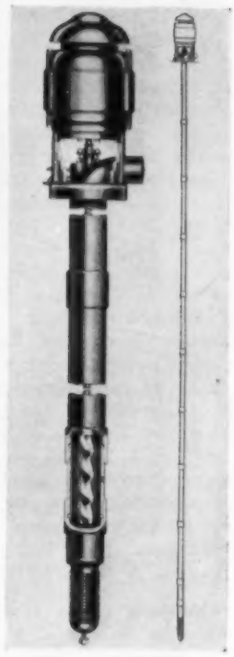
Refrigerant Gas Purger

AUTOMATIC REMOVAL of air and other non-condensable gases from refrigerating systems is the function of a new refrigerant gas purger recently announced by the Armstrong Machine Works, Three Rivers, Mich. The new device works automatically without requiring operating attention after it has once been placed into service. It is stated to remove non-condensable gases practically completely with only a minimum loss of refrigerant gas. The new device is shown in the cross-sectional diagram to consist of an inverted bucket trap and valve mechanism in the lower half, and a ball-float and needle valve in the upper jacketed dome. Connected to the high side of the receiver, the device takes gas from the top of the receiver and just enough liquid from the bottom to keep the cooling jacket filled. The refrigerant gas condenses while the air present collects at the top, depressing the liquid level until the ball float sinks and opens the air release valve. The device may also be used as a combination expansion valve and purger.

This company has also developed a snap-action air trap for draining water from compressed air lines and other compressed air equipment. This trap employs a ball float which is connected to the valve lever through a flat stainless steel spring. As the float rises, the spring stores up energy until it passes dead center, at which time it snaps the valve open. Closing reverses this effect.



New portable turntable crane



Peerless deep well pump

Portable Turntable Crane

A NEW PORTABLE CRANE mounted on a turntable, designed for indoor lifting in restricted space, has been put on the market by the Service Caster & Truck Co. of Albion, Mich. and Somerville, Mass. The machine is telescopic, having a lowered height of 6 ft. 3 in. and an extended height of 10 ft. Maximum travel of the hook is 8 ft. 8 in. The boom length measures 36 in. from the center of rotation. When the machinery is stationary and the handle is up, steel legs lock to the floor. To move about, the handle is pulled forward, lifting the locking legs. The capacity of the machine is 1,000 lb.

Deep Well Pump

ABILITY to obtain maximum capacity from small drilled deep wells (as small as 3 in. in diameter), with lifts ranging from 40 to 1,000 ft., is the outstanding advantage of the new Hi-Lift pump recently put on the market by the Peerless Pump Division of the Food Machinery Corp., 301 West Ave. Twenty-Six, Los Angeles, Calif. The pump is neither of the turbine nor of the plunger type, but it is a modification of the Moineau pump (see *Chem. & Met.*, Oct. 1937, p. 625) originally developed in France. Perhaps the best explanation of the operation of this pump is that it "squeezes" the water along to its destination by the operation of a rolling, spiral-shaped rotor operating within a cutless rubber stator. The pump, which is motor-driven at 1,750 r.p.m., employs cutless rubber bearings at 10 ft. intervals along the entire length of the column pipe. The pump is built in capacities from 5 g.p.m. upward, for pressures up to 500 lb. or more.

Box-Car Loader

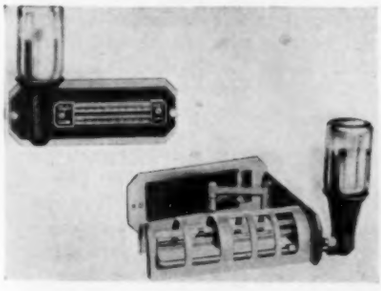
POWDERED, crystallized or granulated materials are quickly loaded into box-cars, trucks, bins or conveyor belts with the loose material loader recently developed by the Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa. This loader is of the slinger type, employing a rapidly moving belt operating at a 90-deg. angle on which rows of wear-resisting metal teeth are fastened to carry the material to the discharge opening. An adjustable deflector regulates the arc taken by the discharged material. Tramp iron, stones and other extraneous materials are ejected for ready disposal. Sizes range upward to 1,500 lb. per min., with equipment driven by gasoline or electric motor, or belt drive.

Duct Psychrometer

TO PROVIDE the maximum convenience in servicing, Taylor Instrument Cos., Rochester, N. Y., has developed a new line of wet and dry bulb psychrometers for use in air conditioning ducts, dryers and other closed compartments, so designed as to swing readily out of the duct or compartment on a triple-hinged bracket. As appears from the accompanying illustration, all parts of the equipment are immediately accessible for wick-changing or other attention. The thermometers are interchangeable and easily replaced, the only tool needed being a screw-driver. All parts of the instrument in contact with the water are treated for corrosion-resistance. For pressure or vacuum of more than ½ in. of water, where a bottle-fed instrument would be impracticable, a design employing a constant-level reservoir is available.

New slinger box-car loader

Closed and open views of duct psychrometer



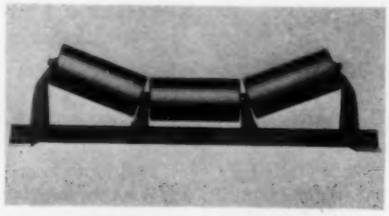
Low-Cost Idler

LOW FIRST COST, a self-cleaning base, free-running anti-friction bearings protected with labyrinth grease seals and equipped with a through grease tube from one bearing to the other, are features of the new Series 43 belt idler recently introduced by the C. O. Bartlett & Snow Co., Cleveland, Ohio. The support brackets are assembled in jigs to assure proper alignment and correct spacing. Slotted holes are provided in the mounting plates to permit the making of any slight adjustment in aligning the belt. The idler rolls are machine faced on the ends and pressed onto shoulders of the cast roll ends whose outer edges are rounded and smoothed to prevent possibility of injury to the belt.

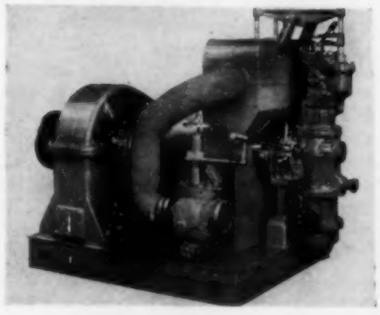
Pump-Priming System

FOR THE AUTOMATIC PRIMING of centrifugal pumps. DeLaval Steam Turbine Co., Trenton, N. J., has developed a new system which, as usually installed, prevents the pump from being operated until priming has been completed. It automatically shuts down the pump until the prime is regained, if it should be lost during operation owing to excessive intake of air. The equipment consists of a steam-, air- or water-operated ejector, mounted within a priming chamber and attached to the suction bells of the pump. This chamber contains a pair of electrodes, one long and one short. Should the water level drop below the longer electrode, a solenoid valve in the ejector supply line is opened and air exhausted from the priming chamber sufficiently to raise water through the pump intake pipe into the priming chamber. Once the water level reaches the upper electrode, the ejector shuts down and the pump starts. Should it be desired to permit dry operation of the pump during priming, this modification can readily be made so that the only function of the automatic primer is to prime the pump upon starting up and to reprime it should its prime be lost at any time during running.

New low-cost belt idler



New general purpose steam turbine



General Purpose Turbine

A LINE of improved turbines ranging from 100 to 2,000 hp. has been announced, following extensive field trials, by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. These multi-stage turbines are intended for driving pumps, fans, compressors, pulverizers and similar machinery. Modifications of one basic design provide for condensing, condensing-extraction, non-condensing, non-condensing-extraction and mixed pressure service. Known as Type M these turbines are available for pressures to 650 lb. and steam temperature to 750 deg. F.

Equipment Briefs

SELF-VULCANIZING RUBBER CO., 605 West Washington Blvd., Chicago, Ill., announces the development of a new single-coat, liquid-rubber primer coating material, which is stated to dry cold to a solid surface within an hour and to withstand temperatures to 212 deg. F. Known as Selfvulc M-A single-coat primer, the new product is used for bonding Airvulc liquid rubber to metals, concrete, glass, tile and other surfaces. Used alone, it is stated to rustproof and waterproof many kinds of surfaces. The material is stated to save several hours drying time as compared with the two-coat primers formerly used.

AN IMPROVED industrial continuous flow pH instrument for remote measurement has been announced by the Coleman Electric Co., 310 Madison St., Maywood, Ill. The new instrument employs an industrial glass electrode which is permanently piped to the process line. The electrode is part of the company's new continuous-flow cell chain. This equipment is connected by an electric cable to one of the company's pH electrometers which may be located at any convenient point up to 50–100 ft. away. Reading of the instrument requires only pressing of a button and reading of a dial.

OPENING AND CLEANING of clogged pipes of all kinds is the function of two new motor-driven "Ferrets" recently developed by the Pittsburgh Pipe Cleaner Co., Oliver Bldg., Pittsburgh, Pa. In

the operation of these tools, a 15-ft. length of helically coiled cable is fitted into the pipe, then spun by the Ferret. A clutch is then released and the cable fed in further. Length after length of cable is added as required, by means of a special coupling. The rapid rotation of the cable scours the line and clears up ordinary obstructions. Special cutting tools, brushes and detachable drills are provided for removing obstinate obstructions. The larger Ferret weighs 85 lb. and is suitable for operation on pipe up to 8 in. in diameter. The smaller, weighing 45 lb., is used for pipe up to 2 in. in diameter.

RECENTLY put on the market by the Ericson Mfg. Co., 5716 Euclid Ave., Cleveland, Ohio, is a new portable explosion- and vapor-proof lamp equipped with a ¼-in. thick Duplate safety glass window through which the light is emitted. Materials used in the lamp housing are non-sparking, including cast aluminum and phenolic resinoids. Since the light can be concentrated, a 50-watt lamp is sufficiently powerful. The weight of this equipment is less than 3 lb.

ABBÉ ENGINEERING CO., 50 Church St., New York City, announces the availability of an improved rotary cutter which is stated to give fast cutting with less heating. The solid rotor to which the fly knives are attached serves as a flywheel to maintain uniform speed in the cutting of non-uniform materials. Less material is carried around with the rotor, therefore bringing it into more frequent contact with the knives. Streamlined construction of the rotor is stated to facilitate cleaning while its solid construction is claimed to give better support to the knives than is possible with the usual spider type rotor.

A RECENT development of the Cowles Detergent Co., 10525 Carnegie Ave., Cleveland, Ohio, is Drymet, a commercial anhydrous sodium metasilicate in powder form, which contains virtually no water, either combined or uncombined. Consequently, it is said not to be deliquescent and to mix well with hygroscopic materials such as caustic soda. Its total alkalinity as N_2O is 51 per cent. It is recommended for use in the manufacture of alkaline cleaning compounds and is stated to improve the effectiveness of such materials as soaps, sodas, phosphates, and other commonly used ingredients.

DESIGNATED as Ultrapaque 1313, a new line of ultra-opaque porcelain enamels for sheet iron cover coats has been announced by the Ferro Enamel Corp., Cleveland, Ohio. It is claimed that the new enamels have an opacity equal to the most opaque of those previously available when applied as a coating 40 per cent thinner. Other advantages claimed include greatly increased resistance to mechanical shock and scratching and the practical elimination of chipping. The new frit is supplied preground to 90 per cent through 200 mesh, for finish milling by the user.

Corrosion-Proof Scale

A RECENT DEVELOPMENT of the Exact Weight Scale Co., Columbus, Ohio, is a corrosion-proof scale of the end-tower type, developed especially for compounding purposes in chemical plants. The special alloy housing is made as moisture-proof as possible. An oil-spray system operated by depressing a plunger conducts a stream of oil to all working parts. Thus the drag which would be introduced by a constant oil pool is avoided. Weighing is done against full-value chrome-plated weights. Capacities up to 15 lb. can be handled. The scale is designed so as to work properly in normal out-of-level conditions.

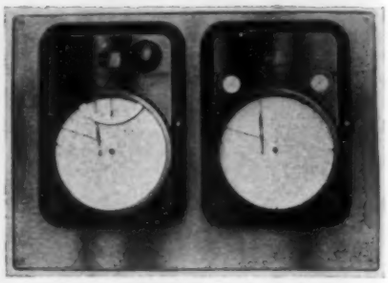
Hydraulic Valve Actuator

LONGER VALVE LIFE through the absence of operating shocks is a principal feature claimed for the new Barnes hydraulic actuator for valves, dampers and gates which is manufactured by W. F. & John Barnes Co., Rockford, Ill., and sold by Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa. The new design employs the special Barnes gear pump capable of supplying actuating pressure up to 1,000 lb. per sq.in. The design eliminates the necessity for the hammer blow required to unseat valves with mechanical actuators and is thus stated to eliminate consequent shock load and assure longer life for the entire structure. The design is applicable to a wide range of speed requirements and operable in either horizontal or vertical positions. An adjustable pressure overload switch is stated to provide safety while insuring positive seating with controlled force. Explosion-proof, weather-proof and water-proof motors are supplied, if desired.

Flow Ratio Control

A RECENT DEVELOPMENT of The Bristol Co., Waterbury, Conn., is a new instrument for automatically controlling the rate of flow of one fluid in definite ratio to the flow of a second fluid. Simply turning a knob on the outside of the case permits instant variation of the ratio. The controller consists of two instruments: one a standard flow recorder and the other a standard flow recorder-controller. The rate of flow is measured and recorded by one instrument which also sets the control point on the second. The latter then records and controls the flow proportionately to the first, depending on the ratio selected.

This company has also developed a new valve positioner for use on diaphragm control valves to overcome the effect of friction in the valve stem and top. This pneumatic device is recommended by the manufacturer for use on all air-operated control installations where close control is of paramount importance and particularly on those where there is considerable process lag. The positioner is said to assure a proportionate valve stem travel for even the slightest change in pressure of the air from the controller.



New flow ratio controller

New rubber disk idler

Rubber Return Idler

TO ELIMINATE wear on the return side of belt conveyors and assure self-cleaning of the idlers, Robins Conveying Belt Co., 15 Park Row, New York, N. Y., has developed the new "Rubberdisc" return idler which consists of a steel tube shaft on which are mounted a series of tough, resilient rubber disks. Within the steel tube are mounted permanently lubricated ball bearings sealed against grit or moisture. The rubber disks, through their slightest deformation at the points of contact with the belt, are stated to give an effective belt cleaning action. Owing to the rubber-to-rubber contact, slippage and abrasion of belt and idlers are claimed to be greatly reduced.

Electronic Viscosimeter

A RANGE of viscosity readings from 75 to 1,000,000 centipoises is accomplished with a single instrument recently announced by the Tech Laboratories, 7 Lincoln St., Jersey City, N. J. The instrument is of the falling ball type, employing electronic indication so that it may be used with opaque liquids of any kind. Using interchangeable tubes, any number of samples may be tested quickly, without cleaning the tubes. Features include accurate positioning and release of the ball and the elimination of parallax through electronic indication. A water jacket is standard equipment. Plastic tubes with unscrewable bottoms can be furnished, if desired.

MANUFACTURERS' LATEST PUBLICATIONS

Building Materials. American Steel Band Co., Pittsburgh, Pa.—4-page leaflet describing this company's new asbestos-protected insulated metal building covering material, with information on typical construction and on heat transmission.

Cable. Anaconda Wire & Cable Co., 25 Broadway, New York City—Publication C-42—54 pages on this company's rubber insulated power cables with information on selection, physical properties, control cables, cable materials, and an extensive section devoted to technical data.

Centrifugals. The Sharples Corp., 2300 Westmoreland St., Philadelphia, Pa.—20-page booklet on this company's Vaporseal clarifiers and their applications in the manufacture of varnishes, enamels and lacquers.

Chains. Moline Malleable Iron Co., St. Charles, Ill.—New illustrated catalog, giving complete listings and new prices on this company's malleable and combination chains and chain attachments, roller chains and steel engineering type chains; also covers sprocket wheels, bucket elevators, and flight conveyors.

Chain Drives. Baldwin-Duckworth Chain Corp., Springfield Mass.—Catalog M—120-page book bound in stiff covers, covering chains and sprockets for power transmission, conveying and elevating with complete engineering and descriptive data and extensive section on selection and engineering of roller chain drives.

Chemicals. Eastman Kodak Co., Chemical Sales Div., Rochester, N. Y.—Organic Chemicals List No. 30—128-page catalog and price list effective May 15, covering numerous organic chemicals offered by this company.

Chemicals. Mutual Chemical Co. of America, 270 Madison Ave., New York City—9-page booklet on corrosion in the refrigeration industry, describing the use of chromates as corrosion inhibitors in the preparation and maintenance of refrigeration brine.

Compressors. Ingersoll-Rand Co., 11 Broadway, New York City—Form 2437—2-page leaflet describing this company's two-stage high-pressure air compressors built in sizes from 7½ to 20 hp. for the starting of internal combustion engines.

Controls. The Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.—Catalog 300—48-page catalog and price list covering this company's complete line of automatic controls for air conditioning, furnaces, burners, stokers, refrigeration and other purposes.

Crushing and Grinding. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1469-E—16 pages on this company's Newhouse crusher with many installations views and complete information on construction. Also Bulletin 1813-F, 24 pages on this company's ball mills with detailed information on construction, dimensions, parts and accessories, types and applications.

Dryers. Buffalo Foundry & Machine Co., Buffalo, N. Y.—Bulletin 316—32 pages on atmospheric and vacuum drum dryers for chemicals, food products and pharmaceuticals with information on advantages, types of application, types of dryer, accessories, design features and feed arrangements.

Dryers. Koppers-Reolaveur Co., Pittsburgh, Pa.—Form E-2—8 pages describing in detail the Carpenter centrifugal dryer for the dewatering of granular materials, and listing typical operating data.

Dry Prints. Eberbach & Son Co., Ann Arbor, Mich.—4-page folder describing this company's Portaprint dry process machine for making positive prints of tracings, drawings and other material.

Dust Control. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1481—8 pages describing construction and advantages of this company's tubular type dust collectors for use in connection with grinding equipment.

Dust Control. W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland, Ohio—24-page book on dust control, listing and describing various kinds of dusts that are being collected, discussing dust hazards and showing how they may be controlled.

Electrical Equipment. Roller-Smith Co., 1766 West Market St., Bethlehem, Pa.—Publications as follows: Catalog 6c, Indoor oil circuit breakers; 11a, Insulator and bushing tester; 11, Potential Indicator; 11 Section 2, Insulation tester; 11-b, Potential indicator; 12, Type C control relays; 6d, Indoor oil circuit breakers.

Electrical Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Descriptive Data 31-133—11-page book on this company's small-plant and industrial a.c. switchboards for 240 and 480 volt circuits.

Equipment. Colloid Equipment Co., 50 Church St., New York City—Leaflet describing ¾-hp. Travis colloid mill for laboratory and small plant use, handled by this company; also leaflet on power-driven laboratory agitator and leaflet describing a new vacuum tube pH apparatus for use with glass electrodes.

Equipment. Ideal Commutator Dresser Co., Sycamore, Ill.—Catalog J-239—84-page catalog and handbook of this company's equipment for motor maintenance, industrial cleaning, variable speed transmission, plant electrical work and similar purposes. Contains numerous useful hints and tables of useful information.

Equipment. The Jeffrey Mfg. Co., Columbus, Ohio—Catalog 87—960-page general catalog covering this company's complete line of chains, reduction and materials handling equipment. Included are conveyors, elevators, chains, sprockets, transmission machinery, electric vibrating feeders, screens, coolers, dryers and crushers, pulverizers, shredders, loaders, stackers, etc.

Equipment. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Catalog 800—1278-page general catalog containing list prices, dimensions, weights and engineering data on power transmission machinery, materials handling, screening, drying, cooling and other equipment. Includes 417 pages on power transmission and drives, 376 pages on chains and sprocket wheels, 343 pages on elevating and conveying machinery, 29 pages of engineering tables, and numerous other sections. Also Book No. 1600, 272 pages on power transmission equipment.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.— Bulletin L-611-B8—8 pages describing construction of this company's feather-valve, single-stage, single-cylinder compressors; S-500-B5E, 8 pages on four-cycle, direct-injection diesel engines; W-321-M3A, 6 pages on jet-operated, deep-well pumps.

Floats. Chicago Float Works, 20 North Sangamon St., Chicago, Ill.—Folder describing a new type of 18-8 stainless steel float made by this company, employing a special stabilizing element to eliminate carbide precipitation in the weld.

Hardness Data. International Nickel Co., 67 Wall St., New York City—Celluloid pocket table listing hardness conversion information for nickel alloy steels; gives standard nickel alloy steel specifications.

Instruments. Precision Scientific Co., 1750 North Springfield Ave., Chicago, Ill.—Bulletin 701—4-page folder, giving complete specifications on a new automatic temperature control Saybolt viscosimeter offered by this company.

Magnets. Stearns Magnetic Mfg. Co., Milwaukee, Wis.—Bulletin 25-A—Describes this company's line of suspended magnets, with information on various applications.

Pipe. Revere Copper & Brass, Inc., 230 Park Ave., New York City—19-page book on this company's copper and brass pipe and tubing, with information on fittings, installation and selection.

Plastics. Bakelite Corp., 247 Park Ave., New York City—15-page booklet describing types of plastics and their applications, designed as a guide to modern plastic materials.

Power Transmission. The Falk Corp., Milwaukee, Wis.—Bulletin 4630 — 4 pages describing the design and principle of operation of this company's recently developed controlled-torque Steelflex coupling, a device which combines this company's standard type of flexible coupling with a friction drive to prevent transmission of shocks, vibrations and overload.

Power Transmission. Stephens-Adamson Mfg. Co., Aurora, Ill.—Catalog 7838—8 pages with description and engineering data on this company's Saco speed reducers.

Screens. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Leaflet 2361—4 pages describing construction and advantages of this company's non-blinding Sta-Kleen low-head screen.

Screens. The Orville Simpson Co., 1230 Knowlton St., Cincinnati, Ohio—Bulletin 86—39 pages on this company's Rotex gyrating screens, showing types, materials handled, users in various industries, and performance records.

Shipping. Acme Steel Co., 2840 Archer Ave., Chicago, Ill.—Form AD7—24-page booklet on "The Story of the Acme Unit-Load," pictorially describing in considerable detail this company's method of steel-strapping numerous types of package for shipment. Also Form AD9, 22 pages on "Stopping Profit Leaks Beyond the Production Line," dealing with this subject in somewhat different fashion.

Steel. Joseph T. Ryerson & Son, Inc., P. O. Box 8000A, Chicago, Ill.—Compact chart giving tensile strength, yield point, elongation and other physical properties of nearly 50 different types of steel carried by this company.

Sump Pumps. Taber Pump Co., 288 Elm St., Buffalo, N. Y.—Bulletin S-135—4-page leaflet on large and small electrically operated sump pumps.

Tables. Denver Equipment Co., 1400 Seventeenth St., Denver, Colo.—4-page leaflet describing the Wilfley concentrating table and showing its application in typical flow sheets.

Tools. Bonney Forge & Tool Works, Allentown, Pa.—Catalog 39—92 pages covering this company's complete line of alloy steel sockets, wrenches and small hand tools.

Treated Canvas. Wm. E. Hooper & Sons Co., Juniper & Cherry Sts., Philadelphia, Pa.—Two new folders on this company's "Fire Chief" canvas, and compound for treating canvas to impart fire, water and weather resistance, with information on use of treated canvas for buildings, industrial, and other purposes.

Chemical Engineering NEWS

Lammot duPont Again Elected Head of M.C.A.

Chemical industry's oldest and most representative trade association, in its 67th annual meeting on June 1, again elected as its president, Lammot duPont of E. I. duPont de Nemours & Co., who had previously served in that capacity in 1933 and 1934. Retiring president, E. M. Allen of Mathieson Alkali Works, presided at a business session which featured enthusiastic discussions of foreign affairs, employer-employee relations and industrial research.

Harold O. C. Ingraham of General Chemical Co. was elected to succeed his associate, Charles W. Millard, on the executive committee. The latter's services to M.C.A. during the past 14 years were publicly commended in a laudatory statement by Mr. Allen.

High-lighting the extensive report of the executive committee, its chairman, Harry L. Derby, president of the American Cyanamid and Chemical Corp., emphasized the industry's obligations in the matter of public relations and education. He reported that "Since the release of 'Facts and Figures of the American Chemical Industry' in September, 1937, as part II of *Chemical & Metallurgical Engineering*, we have distributed about 1,400 copies. A new revision of 'Facts and Figures of the American Chemical Industry' is in the course of preparation for release this fall, and we feel that this will serve a useful function in making available to the lay public and our industry significant reference material." The association has authorized a special study of "Where the Chemical Dollar Goes" by the National Industrial Conference Board and the results will be made available to correct certain misleading conclusions that have been drawn from governmental data on the "Chemical and Allied Industries."

William B. Bell of the American Cyanamid Co., who recently returned from Europe, gave a penetrating analysis of factors influencing the present political situation in Europe. He drew a striking comparison between present conditions and those existing in this country in 1914. We are obviously much better prepared now, from a chemical standpoint, but he averred that war would be a dreadful calamity and no group would be hit harder than American industry.

Henry Clifton, Jr., attorney with Walter Gordon Merritt, stressed the necessity for future humanizing of relations between employers and employees in chemical industry. An open forum brought out other problems resulting from the National Labor Relations Act, wages and hours, Walsh-Healy and similar legislation.

In a characteristically stimulating talk on his favorite subject, "Research," Charles F. Kettering, president of the General Motors Research Laboratories, declared that today any industry finds it hard to keep from being a "chemical manufacturer." The automobile is just a retort for producing H_2O and CO_2—with certain more or less desirable by-products. It owes its origin and progress to research in alloys, rubber, and petroleum. Now that plastics are coming into the picture so prominently with the threat of "plasticizing all of industry," the automobile industry is in need of a whole new vocabulary.

Lammot duPont

Research should be kept separate from either production or sales in Mr. Kettering's opinion. Too many companies spend their money as if they were throwing dice. Often too much money is just as much a handicap as too little. Then there is too much switching of projects and no concerted drive toward the single most important objectives.

When asked the difference between pure and applied research, Mr. Kettering's usual answer is "about 25 years!" The long range studies sometimes help most in solving current problems. Too much has been said about the social significance of research and invention. If the Wright brothers had stopped for such considerations, we would not have had the airplane.

Turning to some of the current political proposals, he likened them to a search for "economic perpetual motion." They will ultimately fail, as have all other perpetual motion processes, through internal friction developed within the machine itself.

The meeting closed in a joint dinner with the members of the Synthetic Organic Chemical Manufacturers Association. Its president, August Merz of the Calco Chemical Co., was toastmaster and the guest speaker was Dr. Robert C. Clothier, president of Rutgers University.

Chemical Engineering Students Meet at Seattle

In order to establish channels for the exchange of technical ideas among students, the first Pacific Northwest Chemical Engineering Convention was held May 12–13 at the University of Washington, Seattle. Chemical engineering students and faculty at the University of Montana, University of Idaho, University of British Columbia, Oregon State College, and Washington State College participated.

The technical session on May 13 was opened with an address by Dean E. A. Loew of the College of Engineering, University of Washington which was followed by the presentation of numerous student papers. The afternoon was devoted to an inspection tour including the recently-constructed wind tunnel for aeronautical research and the new $1,400,000 Bagley Hall in which the departments of chemical engineering, chemistry, and pharmacy are located. At the dinner meeting, A. H. Hooker, Jr., of the Hooker Electrochemical Co., Tacoma, spoke on "Chemical Engineering Opportunities of the Northwest." Oregon State College, Corvallis, will be host for the convention next year.

Tenth Packaging Conference Scheduled for Next March

The tenth Annual Packaging Exposition and Conference will be held from March 26 to March 29, 1940, at the Hotel Astor, in New York City, it is announced by the American Management Association, sponsor of the event, following a poll of exhibitors and packaging organizations. The dates are being set earlier than usual to permit participating organizations to make their plans.

The 1940 program is expected to be built largely along the lines of the last conference, with emphasis on such subjects as informative labeling, efficiency in package production, scientific management in the shipping department, and packaging costs.

M. C. Whitaker Heads Chemical Show Committee

Three floors of Grand Central Palace, New York, have been reserved for the Seventeenth Exposition of Chemical Industries which will be held during the week beginning Dec. 4, marking the 25th year of its service to the chemical and allied industries. Displays of new chemicals and materials of construction will be prominent in the exposition. Exhibit space devoted to displays of plastics will be greatly increased this year and comprehensive coverage is planned for the container and packaging industries.

Other exhibit classifications will include laboratory equipment and supplies, instruments of precision, materials handling equipment, brewing, distilling and bottling equipment, industrial chemical equipment and machinery.

Members of the advisory committee are M. C. Whitaker, vice-president, American Cyanamid Co.; Raymond F. Bacon, consulting chemist; L. H. Baekeland, honorary professor of chemical engineering, Columbia University; F. M. Becket, president, The Chemists' Club; J. V. N. Dorr, president, The Dorr Co.; H. Jermain Creighton, president, The Electrochemical Society; Williams Haynes, editor, *Chemical Industries;* H. E. Howe, editor, *Industrial and Engineering Chemistry;* Webster N. Jones, president, American Institute of Chemical Engineers; Sidney D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering;* W. T. Read, dean of chemistry, Rutgers University; Charles F. Roth, manager of the exposition; H. J. Schnell, general manager, *Oil, Paint and Drug Reporter;* Joseph M. Wafer, president, Salesmen's Association of American Chemical Industry; R. Gordon Walker, vice-president, Oliver United Filters, Inc., and Charles A. Kraus, president, American Chemical Society.

Paint Research Fellowship Established at Case

Case School of Applied Science has received a grant of $700 from the National Federation of Paint and Varnish Production Clubs, it has been announced by Dr. C. F. Prutton, head of the chemical engineering department. The major part of the grant, $600, will be paid to a research assistant who will conduct his experiments at the college. The remainder of the grant will be used to purchase the necessary equipment and supplies. The Cleveland Paint and Varnish Production Club, through its scholarship committee, has also announced a gift of $200 to the college to assist in the establishment of a paint and varnish research laboratory.

Other gifts received by the chemical engineering department include a gift of $150 from the Manufacturing Chemists Ass'n. of New York; a $1500 high pressure pump from the duPont Ammonia Division, Wilmington, and a $200 variable vacuum tube oscillator from the American Telephone and Telegraph Co., New York. The gift from the Manufacturing Chemists Ass'n. will be used to purchase apparatus for a study of the melting point of sulphuric acid. The triplex plunger pump given by the duPont Co. will be used for compressing gases used in high pressure chemical reactions. The pump is capable of generating pressures up to 15,000 pounds per square inch. The oscillator given by the Telephone Co. will be used in making accurate measurements of the electrical conductivity of solutions.

Norris Laboratory to Remain Under Bureau of Mines

While the Bureau of Mines has been operating the Norris laboratory for the T.V.A. for nearly a year, funds for continuing the work after July 1 are included in the Bureau's own appropriations. Hewitt Wilson, ceramist from the University of Washington, will continue in immediate charge, under the general direction of O. C. Ralston. The objective of these experiments is to develop uses for electricity in the treatment of nonmetallic minerals.

Because of the increased interest in light metals an additional $35,000 is carried in the new Appropriation Act for the experimental work, begun last year, on processes of making metallic magnesium at the Pullman, Wash., laboratories.

Move to Conserve Phosphate Deposits of Florida

In a move toward conservation of undeveloped phosphate resources in Florida—estimated as comprising a potential supply of 20,000,000,000 tons—the Secretary of the Interior has ordered an investigation into the advisability of reserving the right of the United States in such mineral deposits in connection with applications for sale or lease of any portions of the public domain in that State.

Fertilizer Association Meets At White Sulphur Springs

Over 500 fertilizer manufacturers, soil scientists, and agricultural leaders heard W. T. Wright, president of The National Fertilizer Association, open the first general session of the Association's Fifteenth Annual Convention at White Sulphur Springs, on June 6. Mr. Wright, who is also vice-president of F. S. Royster Guano Co., Norfolk, told the Association that continuing aggressive work in soil improvement must be carried on by the industry. "The industry cannot prosper unless the farmer prospers, and the farmers on one-sixth of the cultivated land of the nation cannot prosper without the use of fertilizer. It is to the advantage of both the industry and agriculture to work for the most efficient and economic use of fertilizer on the varied soils of the country."

Charles J. Brand, executive secretary and treasurer of the Association, in his address on "Industry Problems of Today," touched on the current investigation by the Department of Justice of the industry's trade practices. "This is an industry which is dominated by the laws of chemistry, physics, and biology," said Mr. Brand. "The same immutable rules govern the fertilizer industry that govern the 60,000,000 acres of fertilized land on the farms of the country. These natural laws force the industry into an inevitable pattern."

"Because of the complexity of the scientific laws which control the industry, there arise many popular misconceptions concerning it," he added. He pegged the inaccuracy of the story that fertilizer prices are high and out of line with other products by quoting indexes compiled by the Department of Agriculture for prices paid by farmers for commodities in March, 1939, which showed fertilizer prices to be lower than any commodity in daily use by farmers, with the exception of feed.

Mr. Brand said that recent scientific developments in both the manufacture and use of fertilizer have established economies which are reflected in lower costs and higher yields for farmers.

Production and sales of certain synthetic resins, 1938

	Production	Sales		
	Lb.	Lb.	Value	Unit value
Coal-tar: Total	106,923,244	84,763,503	$15,810,538	$0.19
Alkyd resins:				
Maleic anhydride	3,432,887	2,978,718	634,935	.21
Phthalic anhydride	37,563,840	21,931,783	4,467,466	.20
Derived from tar acids:				
Cresols or cresylic acid	5,284,895	3,882,988	561,432	.14
Phenol:				
For molding	13,487,681	12,787,051	2,189,600	.17
For casting	4,807,671	4,651,991	1,896,425	.41
Other	17,658,391	17,484,415	2,939,971	.17
Xylenols	329,927	.....	.....	.....
Xylenols and cresols	2,396,273	.....	.....	.....
Non-coal-tar: Total	23,435,408	17,064,685	7,061,436	.41
Urea	8,249,900	7,467,782	3,312,678	.44

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

TAX REVISION for the benefit of business has been arranged. Senator Harrison by a near ultimatum secured the President's consent. The Senator, chairman of the powerful finance committee of the Senate, merely called attention to the fact that when necessary reenactment of excise laws came up to his committee, he would find it necessary to add business tax revisions as a part of the program. The graceful thing, politically necessary, for the President was to say, "Go ahead and revise the taxes which business wants fixed."

But the President insists that this will not be tax reduction. The Treasury must not suffer, so he says. And with Congress appropriating much more money than even an overgenerous budget provided for, the President is unquestionably right on this part of the argument. An all-time record deficit is to be expected next year despite anything which Congress can now do.

Legislation Planned

Before Congress goes home early in August, it must pass some important bills. Up to June 1 it had practically not legislated on anything very important except appropriations. The "must pass" list the first week of June appears about as follows:

1. A tax bill, reenacting excise taxes and modifying some of the most obnoxious business income features.
2. A neutrality bill, modifying the present law—but how nobody can yet guess.
3. Provision for relief appropriations.
4. Establishment of some new form of Government guarantees of loans to small business.
5. Monetary legislation, extending the President's authority over the stabilization fund and for regulation of the gold value of the dollar, with probable extension of the President's authority to buy virgin domestic silver at a bonus.
6. Social security law amendments postponing increase in old age tax rate and perhaps modifying other features.

Much less certain, but still probable, are changes in the wage-hour law providing amendments wanted by Administrator Andrews; final enactment of the stream pollution control law; creation of a joint committee for banking and monetary study, to report to Congress next year; postponement of the effective date of the food and drug law with respect to certain label provisions; final enactment of the law providing $100,000,000 for stock piles of strategic materials (signed by the President, June 8); and a flock of other measures important but not as directly of concern to process industry.

Alcohol Tax, Up or Down?

Bills nominally providing for redu tion of the tax on alcohol used for other than beverage purposes, but still taxable because not denatured, created quite a stir among alcohol producers and users. The way these were phrased made it possible that even the alcohol denatured for industrial use might have to pay a tax of $1.10 per proof gallon.

All interested in this important industrial solvent are being urged to write to their congressmen and senators as well as to Representative Harold Knutsen of Minnesota, author of the House bill. Washington gossips as to whether the bill was a clever scheme for increasing the tax on alcohol, or whether the form which has the effect of imposing a new tax was accidental.

Blocking Out Minerals

The Bureau of Mines will undertake to block out mineral reserves for certain strategic materials when it gets the money provided by the strategic materials stock pile bill. This is regarded by Director Finch of the Bureau as being one of the major jobs which his Bureau should undertake with the $350,000 per year so to be provided. He, it appears, is going to leave most of the economic and resource studies to U.S.G.S., which also has an allotment of $150,000 per year under this same law.

The Bureau of Mines will go out on some of the more promising strategic properties and actually do test hole digging or boring in order to block out ore bodies in a preliminary fashion to permit dependable estimates of the reserve which is there. This takes substantial sums for each property studied. It is obvious that the number of field inquiries of this character will not be large. Also planned by the Bureau are metallurgical investigations of new methods for processing of ores for which dependable technics are not now available.

As a novel feature in the TNEC proceedings, the Department of Justice brought up the question of beryllium and its alloys for a two-day hearing early in May. There was no statement made officially as to the purpose or expected monopoly significance. This resulted in much speculation as to both the purpose and the consequence.

News "Fines"

Latin American Politics—There was an important business story behind the Argentine canned beef episode. Argentina always carries a chip on its shoulder with respect to American restrictions on beef. Much happier trade relations could be developed if the President could somehow find a technic for getting Western range-country Senators more favorably disposed toward this important Latin neighbor. But how the President expected his canned beef compliments to do this is not clear.

Pricing Corn Products—Eight makers of starch, syrup, and sugar from corn are charged by the Federal Trade Commission with price discrimination in violation of the Robinson-Patman Act. It is alleged that the prices for these goods unwarrantably influence the competition of this industry's customers. The whole field of making and using corn products is, therefore, open for review.

Patent Law Changes—Although Secretary Hopkins early in June suggests to Congress some changes in the patent law, following Commissioner Coe's recommendation some months ago, there is no likelihood of legislation this year on this subject.

Anti-Trust Problems—Fertilizer industry is still fretted by Justice Department inquiries and nervously awaits the outcome of grand jury hearings in New York. Meantime the potash industry is striving to set its house in order and Washington gossip suggests stipulations as the way out for that division of the fertilizer business.

Fertilizer Freight Rates—The National Fertilizer Association is rejoicing that I.C.C. at last declined to make the requested additional 10 per cent increase in southern freight rates on fertilizer materials. The N.F.A. argued, effectively, that an increase of 4½ per cent which took place in January was plenty.

Working Hours Defined—Employees required to report at some point other than their working place must be considered at work from the time when they are required to be available. Waiting time required for the convenience of the employer is also working time. These and other generalizations are interpretations of the Wage-Hour Act, somewhat clarifying the calculation of workers' rights on jobs of irregular sort or employment at variable locations.

Coal Tar Colors—Hearings will be held beginning July 5 on proposed additions and changes in the list of coal tar colors which may be certified for use under the Food, Drug, and Cosmetic Act. Makers and users interested should get the proposed amendments in the Federal Register published June 3.

GERMAN INDUSTRIAL GROUPS PUSH RESEARCH IN FIELD OF RARE EARTHS

From Our German Correspondent

TO STIMULATE research and to find new industrial uses for available raw materials, a number of scientific organizations and industrial groups in Germany are offering cash prizes for the best solutions to certain scientific and technical problems. Leading among these are two 10,000 RM prizes offered by the Auer Research Foundation, named after the Austrian chemist, Carl Auer, inventor of the Welsbach mantle. This foundation, trying to encourage research in the field of rare earths and illumination, is offering a prize for the best process submitted for better utilization of gases and more effective lighting with thorium and cerium oxides containing Welsbach mantles. Although the use of Welsbach burners for household illumination has declined in Europe as in America, in Germany they are still being used extensively for portable lanterns and street lighting.

Another Auer prize is being put up for the development of new commercial uses for lanthanum compounds. In producing the Welsbach mantles, after removing thorium and cerium oxides from monazite sands, considerable lanthanum compounds remain, partly in mixture with neodymium and praseodymium compounds. (58 per cent lanthanum oxide, 32 per cent neodymium oxide, 8 per cent praseodymium oxide, and 2 per cent samarium oxide and ytterbium earths.) The amount of these other compounds available has increased with greater production of thorium, especially as it has been used lately as a catalyst in the Fischer-Tropsch benzine synthesis. The cerium, praseodymium, and neodymium compounds have found good use in the glass and ceramic industries for coloring and glazing. So far no practical use has been found for lanthanum, although its use in compounds for loading silk and rayon, suggested in an expired patent, is also being considered again.

The Deutsche Gesellschaft fuer Fettforschung is offering a 2,000 RM prize for a better method of determining free alkalis and alkali carbonates in soaps. Present methods, according to the society for research with fats, are neither accurate nor quick enough.

The association of German Portland cement manufacturers is offering prizes for answers to three of this industry's problems: (1) developing of crack-free concrete with existing German cements, (2) quicker analytic methods to determine Al0 in Portland cements, (3) determination of the relationship of vitreous matter in cement clinker to the method of cooling. Scientifically-useful studies in the field of caoutchouc research will also be awarded cash honors by the German Kautschuk Gesellschaft. The Max Buchner Research Foundation has just published the winning solutions for improved methods of cleaning aluminum apparatus in chemical technique.

At the same time, industries in their own laboratories and technical institutes are carrying on experimentation on the utilization to the fullest extent of available domestic raw materials. Already 80,000 tons of sulphur are obtained from coke oven gases. It is estimated that 260,000 tons could be produced annually if the sulphur-containing gases of all German coking and filtration plants were utilized. Another estimated 90,000 tons could be obtained by recovering sulphur from gases in roasting pyrites of iron, copper, zinc and lead.

Liquid industrial wastes form another source of raw materials being explored extensively. Acid used in galvanizing, metal, and tanning plants is being regenerated until it is almost completely used up. The residue is estimated to contain, in addition to 1 to 4 per cent free H_2SO_4, up to 400 gr. iron sulphate per liter, 100,000 tons of iron sulphate is thus available yearly for blast furnaces. The increased demand for phenols in German plastic industries has caused more attention to be paid to waste waters of cokeries, gas plants, and lignite carbonization and hydrogenation plants. The dephenolization of cokery waste, which is stated to contain about 2 gr. phenol per liter, is being carried out by the Emscher Genossenschaft, a cooperative which has erected 15 plants, which recover 90 to 95 per cent of the phenol contained in gas pipe water. It is processed further by tar factories before it is turned over to the synthetic resin industries.

New processes are already being applied to utilize the 100,000 tons of "red mud" oxides recovered annually in the processing of alkali bauxite in aluminum manufacture. The "red mud" is used as a contact mass for coal hydrogenation, for cleaning illuminating gases, and as an ingredient in brick manufacture.

The sulphite cellulose factories of Germany turn out upwards of a million tons of lignin every year for which no technical economical use has yet been found. The best possible utilization of forest products is causing beech and small firwood fir to supplant the less abundant pine in cellulose production. The manufacture of sugar and fodder from wood shavings and waste, coking of wood, and the burning of wood waste as fuel in wood gas generator-driven trucks are some of the other uses to which wood is now being put. Cellulose waste liquor occurring as a byproduct of the wood-pulp industry is being used in soap manufacture, for the production of alcohols and fodder proteins.

Cellulose containers for motor oil have been successfully tried out by the German army. A cellulose container impregnated to resist oil has been developed by the army materials office as a substitute for glass or tin containers for carrying smaller quantities of oil directly on motor vehicles. The new container is lighter and takes up less space, but has the disadvantage that it can be used only once.

That synthetic Buna rubber is being used satisfactorily as insulating material in ocean cables is reported by the Norddeutsche Seekabelwerke in Nordenham. The firm has developed cable insulation of Buna mixed with refined gutta percha or balata. In actual use it has demonstrated satisfactory electrical insulating as well as mechanical properties. Since the Buna is already free of impurities and does not have to be specially treated as natural caoutchouc and gutta percha for the removal of impurities, the use of Buna is claimed to simplify the production of undersea cables.

Of interest at the Hamburg meeting of the German society for research on fats is a report on the use of fish oil in paints. Specially treated oils of this kind are being mixed with mineral oils. The application of fish oil in combination in the standardized "El-Firnis" varnish is not yet satisfactory, and its use in painting interiors is handicapped by the fact that the odor given off by the fish oil has not been completely eliminated.

A process for detoxifying city gas has recently been patented (D.R.P. 663 575) by the Gesellschaft fuer Gasentgiftung G.m.b.H., Berlin The patent description claims that the B.t.u. and other norms of non-detoxified city gas are maintained. The poisonous CO content is reduced to 1 per cent through a single water vapor catalytic treatment at a temperature between 350 and 500 deg C. without a subsequent methane catalysis and without washing out CO_2.

The Aussiger Verein, formerly Czecho-Slovakia's leading chemical concern (*Chem & Met*, Sept. 1937), whose plants are mainly located in Sudetenland, has been reorganized as the Chemische Werke Aussig-Falkenau G.m.b.H., with control equally divided between I. G. Farben and the Chemische Fabrik von Heyden.

Both from the strategic and economic standpoint, Rumania's recent trade agreement with Germany is significant. In the first half year 1938 the Reich supplied 37 per cent of Rumania's total imports and took 2.6 per cent of her total exports. In 1937 Rumania was the world's sixth largest producer of oil, behind only the United States, Soviet Russia, Venezuela, Iran, and the Netherlands. Her mines yield salt, lignite, iron, copper, pyrites and zinc in moderate quantities, and an important byproduct of her oil wells is natural gas.

PERSONALITIES

Francis C. Frary

✦ FRANCIS C. FRARY, director of research of Aluminum Co. of America, will receive the 1939 Edward Goodrich Acheson gold medal and $1,000 prize from the Electrochemical Society at the fall meeting of the Society. The award will be made for distinguished contributions to the electrometallurgy of aluminum as well as to other scientific fields. He was president of the Society in 1930.

✦ F. M. BECKET has been elected president of the Chemists' Club of New York. Dr. Becket is vice president of the Union Carbide Co.

✦ GEORGE GRANGER BROWN, professor of chemical engineering at the University of Michigan, was awarded the 1939 William H. Walker Medal of the American Institute of Chemical Engineers at the recent meeting in Akron, Ohio. The medal is awarded annually for an outstanding contribution to chemical engineering literature.

✦ V. N. IPATIEFF, director of chemical research of the Universal Oil Products Co., received the honorary degree of Doctor of Chemistry from the University of Sofia, Bulgaria, on May 20, during the celebration of the fiftieth anniversary of the founding of that institution. Dr. Ipatieff has just been elected a member of the National Academy of Sciences in recognition of his achievements.

✦ ARTHUR E. BEARCE has joined the staff of Battelle Memorial Institute, Columbus, Ohio. He has been assigned to the industrial chemistry division. Dr. Bearce, who received his graduate degree from the Massachusetts Institute of Technology, was formerly associated with Arthur D. Little, Inc. Previous to that he had been at the Jackson Laboratory of E. I. duPont de Nemours & Co.

✦ DANIEL B. CURLL, JR., resigned June 1 as chemist of the Philadelphia Quartz Co. to join the staff of the Rumford Chemical Works, where he will be assistant to the president, A. E. Marshall. Previous to joining Philadelphia Quartz Co. he had served with du Pont Ammonia Co. at Wilmington, Del., and Charleston, W. Va.

✦ JAMES COLEMAN has been moved up to the general superintendency of the Paraffine Companies, Inc., San Francisco.

✦ E. C. DREBY has been appointed research associate of the Special Committee for Testing of Textile Finishes of the A.S.T.M. The research program will be carried out at the National Bureau of Standards.

✦ ODON S. KNIGHT, formerly a teacher at the University of Colorado and recently employed by the J. P. Devine Co., has accepted a position on the faculty of Rose Polytechnic Institute, Terre Haute, Ind. He will have charge of the courses in unit operations of the chemical engineering department.

✦ G. F. GARNATZ has been elected president of the American Association of Cereal Chemists.

✦ E. L. MACK, for the past ten years director of development and research for Reynolds Metals Co. and United States Foil Co., has retired from active to a consulting capacity. He will maintain an office in New York, N. Y.

✦ WILLARD H. COBB, for the past several years general factory manager, mechanical goods plants, United States Rubber Co., has been appointed general manager of the mechanical goods and general products divisions.

✦ JESSE E. STARECK, now engaged in research at the laboratories of United Chromium, Inc., Waterbury, Conn., on May 17 received the Edward Longstretch medal of the Franklin Institute for his development of electrolytic color plating.

✦ MARLIN D. GEIGER, works manager of the South Charleston, W. Va., plant of Westvaco Chlorine Products, has been elected to the Board of Directors of the company.

✦ ALFRED C. CALLEN, head of the Department of Mining and Metallurgical Engineering at the University of Illinois since 1924, has been appointed dean of the College of Engineering and head of the Department of Mining Engineering at Lehigh University. His appointment is effective September 1.

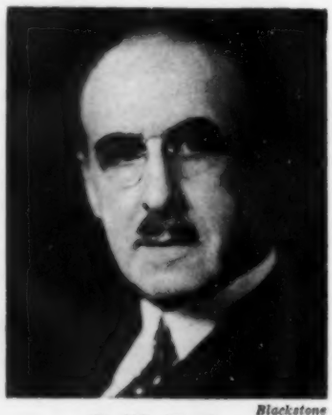
✦ J. EARL SIMONDS is now a consultant, specializing in the plastics industry. His offices are at Summit, N. J.

✦ W. T. READ, dean of the School of Chemistry at Rutgers University, has been elected vice president of the national organization of Phi Lambda Upsilon.

✦ PETER C. REILLY, president of the Reilly Tar & Chemical Co., has been awarded the honorary degree of doctor of laws by the University of Notre Dame.

✦ J. C. WITT has been appointed technical service manager of the Marquette

V. N. Ipatieff



Blackstone

F. M. Becket

Shepard's

Daniel B. Curll, Jr.

Robert L. Holliday

George Granger Brown

Cement Manufacturing Co. He will be located in Chicago. His activities include the correlation of all the technical work of the company. For several years Mr. Witt has specialized in the production and application of cements and other materials of construction.

✦H. C. WILLIAMS has been made general plant superintendent of the H. K. Porter Co.

✦FRANK C. CROXTON, for the past nine years research chemist with the Standard Oil Co. of Indiana at Whiting, Ind., has joined the research staff of Battelle Memorial Institute, Columbus, Ohio.

✦PAUL F. WACKER, an Ohio State University graduate, has joined the staff of Battelle Memorial Institute. He has been assigned to the ceramic division. J. Alfred Curtis, another graduate of the same university, also has joined Battelle.

✦MAX MAYER, formerly the technical director of the Russig Verein, chemical and metallurgical manufacturers of Czecho-Slovakia, has opened a consulting office in New York, N. Y.

✦WAYNE L. NIELSEN, who received his chemical engineering degree from Michigan State College and later was employed by the General Chemical Co. is now at the Kenvil, N. J., plant of the Hercules Powder Co.

✦ALOIS LANGER, T. A. READ, A. H. RYAN, G. L. TAWNEY and W. A. JOHNSON have been appointed in the second group of Westinghouse Electric & Manufacturing Co. research fellows. They will work at the company's research laboratories in East Pittsburgh, Pa.

✦H. Y. BASSETT has joined the staff of the Wolverine Tube Co., Detroit, as research engineer.

✦FRANK K. CAMERON has been awarded the Herty Medal. The medal is awarded annually to some outstanding Southern chemist by the Department of Chemistry at the Georgia State College for Women at Milledgeville. Professor Cameron is on the faculty at the University of North Carolina.

✦S. G. BLAYLOCK, formerly vice president of Consolidated Mining and Smelting Co., was appointed President.

✦JAMES BUCHANAN, formerly general superintendent of Consolidated Mining and Smelting, was made general manager.

✦R. W. DIAMOND, formerly assistant general superintendent of Consolidated Mining and Smelting Co., was appointed assistant general manager of the Canadian company.

✦F. MILLER FARGO, JR., executive vice president of Calco Chemical Co., Bound Brook, N. J., has been elected president. He succeeds Robert C. Jeffcott who retired May 1.

✦PETER D. COOPER has been appointed plant manager and S. B. Roberts chief engineer of the Pearisberg, Va., plant of Celanese Corp. of America.

✦HAROLD P. CONNARE, a senior chemical engineering student at Ohio State University, has been chosen as this year's recipient of the Toulmin Award.

✦J. N. FORKER, a vice president and director of Koppers Co., in charge of tar and chemical division, has been appointed to the board of the Eastern Gas and Fuel Associates, Boston.

✦ROBERT L. HOLLIDAY died on May 3 at his home in Miami, Fla. Death was caused by coronary thrombosis. He had served with the General Chemical Co., Spray Dryer Products Co., E. I. duPont de Nemours & Co., N. J. Zinc Co. and other companies in the chemical industry.

✦ARTHUR E. WELLS, a director of the American Cyanamid Co. and manager of the Beetle Products Division, died in Boston, Mass., May 24, after an illness of several months. He was 54 years old. After graduation from the Massachusetts Institute of Technology, Mr. Wells had been associated with American Smelting & Refining Co., the United States Bureau of Mines and Harvard University before joining the Cyanamid organization in 1930.

✦JOHN FIEBING, head of the Fiebing Chemical Co. of Milwaukee, Wis., died April 13, after a short illness.

CALENDAR

JUNE 26-30, AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J.

SEPT. 11-13, ELECTROCHEMICAL SOCIETY, fall meeting, Hotel Commodore, New York, N. Y.

SEPT. 11-15, AMERICAN CHEMICAL SOCIETY, fall meeting, Boston, Mass.

SEPT. 12-14, TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, fall meeting, Hotel Syracuse, Syracuse, N. Y.

NOV. 13-17, AMERICAN PETROLEUM INSTITUTE, annual meeting, Stevens Hotel, Chicago.

NOV. 15-17, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Providence-Biltmore Hotel, Providence, R. I.

DEC. 4-9, CHEMICAL EXPOSITION, Grand Central Palace, New York City.

Chemical ECONOMICS and MARKETS

CONSUMPTION OF CHEMICALS CONTINUES TO HOLD GAINS OVER LAST YEAR

FROM PRELIMINARY reports and data, there was not much improvement in the volume of chemical consumption in May over the April level. Seasonal influences lifted sales of paint and varnish but the rise was not fully up to expectations and it is anticipated that June will be the peak month for sales. Petroleum refining gained substantially in May but textiles, iron and steel, and fertilizer manufacturers operated on a lower scale. The preliminary index of Chem. & Met. for consumption of chemicals for May was slightly over 114 which compares with 98.33 for May last year, so that the rate of increase over 1938 as established in the first quarter of this year is still being maintained with indications that June will add further to the relative increase.

***Chem. & Met.* Index for Consumption of Chemicals**

	March Revised	April
Fertilizer	23.84	23.09
Pulp and paper	16.35	15.27
Glass	11.80	11.35
Petroleum refining	12.91	12.96
Paint and varnish	10.68	10.98
Iron and steel	7.05	6.58
Rayon	9.00	8.26
Textiles	7.99	6.88
Coal products	6.96	5.91
Leather, glue and gelatine	4.52	4.05
Explosives	4.06	3.84
Rubber	2.76	2.51
Plastics	1.90	1.84
	119.82	113.52

The final revision of the March index advances the total to 119.82 largely as a result of the release of unexpectedly high totals for pulp production which combined with a large consumption of waste paper in the manufacture of paperboard, accounted for a healthy increase in the use of chemicals in the pulp and paper trade.

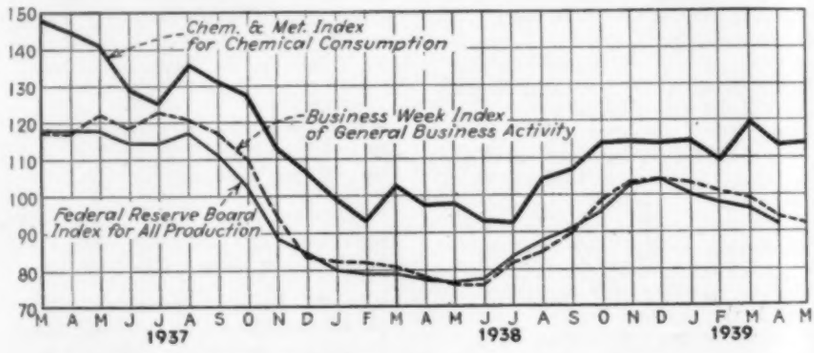
The glass industry has shown spotty conditions with the container branch holding up well and a disappointing report on flat glass production although the outlook for the latter is held promising.

Operations at textile mills ran at a relatively high rate over the first quarter of the year but has since fallen off with high prices for silk operating to restrict activities at silk plants. It is also reported that southern print mills are planning a 25 per cent reduction in working schedules which will probably be reflected in mill takings of cotton in the next three months.

Fertilizer output has run ahead of earlier prognostications and consumption of sulphuric acid in the superphosphate branch ran counter to the seasonal trend in April with an output of 286,747 tons of bulk goods and a sharp rise in production of base and mixed goods. As a result the April index for fertilizers fell but little below the March figure.

Despite labor troubles which affected the supply of bodies, production and sales of automobiles in May are reported to have been at a high rate. Private estimates place sales for that month at about 312,000 units which, if correct, would represent a sharp increase over the total sold in May 1938.

The preliminary index of employment for all manufactures in April was 91.3 which was 0.1 per cent under March and 6.5 per cent above April 1938. For chemicals and allied products the employment indexes were 114.4 for March, 114.8 for April, and 112.4 for April 1938; for chemicals alone, 116.5 for March, 114.9 for April, and 111.4 for April last year; for explosives, 81.3 for March, 80.8 for April, and 81.4 for April last year; for fertilizers, 132.2 for March, 159.4 for April, and 136.3 for April last year; for paint and varnish, 114.9 for March, 117.6 for April, and 114.2 for April last year; for soap, 90.5 for March, 88.4 for April, and 86.9 for April last year.

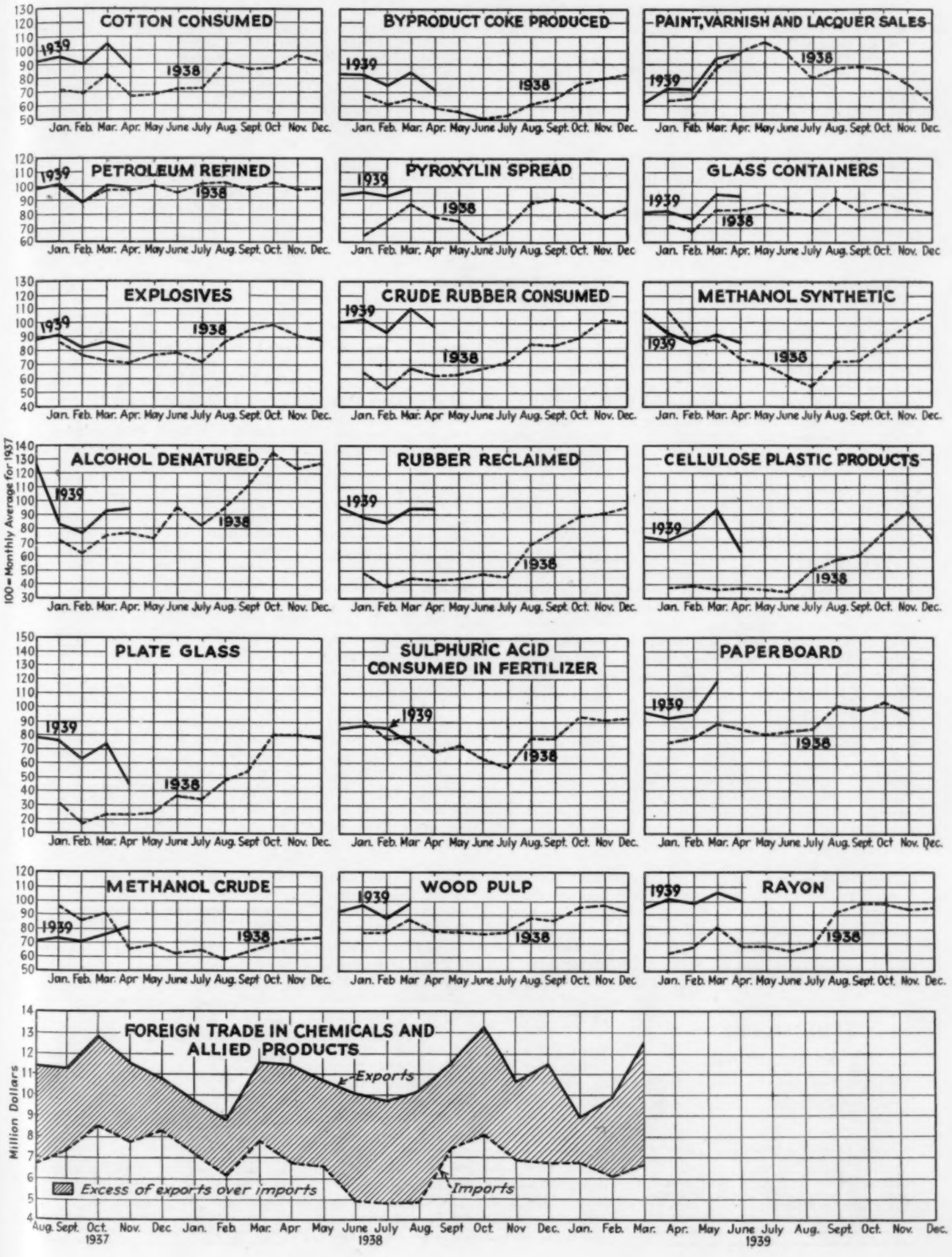


The wood distillation branch of the chemical industry was somewhat more active in April, carbonizing 36,176 tons of wood and turning out 389,423 gal. of crude methanol which compares with 364,000 gal. in March and 314,664 gal. in April last year. On the other hand producers of synthetic methanol cut production from 2,406,564 gal. in March to 2,276,385 gal. in April although the April total was 300,386 gal. in excess of that for the comparable month of 1938.

Production and Consumption Data for Chemical-Consuming Industries

	April 1939	April 1938	Jan.–April 1939	Jan.–April 1938	Per cent of gain for 1939
Production					
Alcohol, ethyl, 1,000 pr. gal	17,859	12,817	67,020	63,518	5.5
Alcohol denatured, 1,000 wi. gal	7,719	6,287	28,617	23,465	22.0
Ammonia liquor, 1,000 lb	3,960	3,480	16,631	14,310	16.2
Ammonium sulphate, 1,000 lb	79,269	68,648	347,681	284,283	22.3
Benzol, 1,000 gal	6,813	5,385	29,805	23,113	28.9
Byproduct coke, 1,000 tons	2,915	2,436	12,798	10,367	23.4
Glass containers, 1,000 gr	4,071	3,647	15,178	13,34	13.2
Plate glass, 1,000 sq. ft	7,268	3,820	41,509	15,405	169.5
Cellulose acetate plastics, 1,000	1,244	729	6,766	2,949	129.4
Nitrocellulose plastics, 1,000 lb	1,116	690	4,404	2,766	59.2
Rubber reclaimed, tons	14,527	6,597	55,911	26,951	107.4
Consumption					
Cotton, bales	546,702	413,169	2,350,223	1,785,919	31.6
Silk, bales	27,802	33,381	139,700	129,240	8.1
Wool, 1,000 lb	27,726	15,962	125,642	63,155	98.9
Automobiles, factory sales	337,372	219,310	1,346,345	837,164	60.8
Explosives, 1,000 lb	26,341	22,961	109,991	98,747	11.4
Rubber, crude, tons	44,166	27,984	182,930	111,768	63.7
Waste paper, tons	262,918	224,715	1,036,413	886,757	16.9

Production and Consumption Trends



PRICES FOR MANY CHEMICALS EXTENDED TO DELIVERIES OVER REST OF YEAR

WITH THE opening of the current month, a broader call for delivery of chemicals was reported. There was an irregularity in demand, however, with some consuming industries failing to correspond with the general trend. In some cases, particularly some of the agricultural and insecticide chemicals, demand has been large enough to take up current offerings and speed up productive activities. Water-treatment chemicals also have been moving freely.

Prices of the more important chemicals have shown a steadiness that would indicate bottom levels have been reached. In several instances current quotations have been extended to cover deliveries over the remainder of the year. Naval stores have followed an irregular price course with some of the rosins declining under a disappointing consuming demand.

Vegetable oils have been featured by a rise in asking prices for China wood oil in both primary and domestic markets. Domestic holders have offered sparingly and the period closed with values more or less nominal. Substitute oils have been benefited by the China wood oil situation and more interest has been manifest in such products as perilla, oiticica, and special castor oils. Steady advances in Argentine seed markets have strengthened values for linseed oil but a good trading movement has placed most consumers in a position where they are covered ahead for several months.

Coconut oil was of interest because of Senate action which will place imports from the Philippines on a quota basis from 1940 to 1946, the year specified for Philippine independence. The quota for next year is placed at 200,000 long tons which is to be reduced by 5 per cent in the subsequent years. Should imports run over the quota, the excess will be subject to import duty.

As an indication of the larger call for raw materials by the paint and varnish industry this year, the Lead Industries Association reports that production of lead pigments — not including orange mineral—for the first three months amounted to 44,951 tons or an increase of more than 34 per cent over the corresponding quarter of last year. Production was distributed as follows: litharge, 17,723 tons, red lead, 7,270 tons, white lead, dry, 5,918 tons, and white lead, in oil, 14,040 tons.

The National Fertilizer Association reports that total fertilizer sales in 17 states in May, as indicated by the sale of tax tags, amounted to 390,982 tons. This was 18 per cent larger than sales in May1938 and 26 per cent larger than sales in May 1937. The increase over recent years probably reflects the late season, which had also influenced April results.

Aggregate sales in the first 11 months of the current fiscal year, from July through May, were 5,330,734 tons. This represented an increase over the corresponding period of last year of 4 per cent.

An increase of 13 per cent in May over last year in the south was due to marked increases in Virginia, North Carolina, Florida, and Tennessee, which more than offset declines in several of the other states. Total sales in the southern states in the January-May period were somewhat above last year but they were 400,000 tons under the same period of 1937. Four of the five states in the midwest reported increases in sales in May over last year. For the region as a whole the increase amounted to 41 per cent.

Patents covering processes for the recovery of sulphur from gases developed in metallurgical operations, jointly owned by British and Swedish groups and those which are owned by German and Swiss interests are to be pooled, according to a recent report to the Department of Commerce, from the office of the American Commercial Attache at London. These groups have commercialized their processes and now have placed their patents and processes in the hands of a newly formed company, known as Sulphur Patents Limited, to handle licensing operations. The output of sulphur by the British, Swedish, German, and Swiss companies will be marketed by Lurgi Chemie, located in Frankfort.

Statistics issued by the British Board of Trade show the output of synthetic organic dyestuffs in the United Kingdom during 1938 amounted to 45,502,043 lb. compared with 63,265,000 lb. in the preceding year, a decrease of 28 per cent. Authorities attribute this appreciable recession in production largely to the fact that the domestic dye-consuming industries had laid in large stocks of dyes during 1937 on the expectation of an advance in price.

Exports of chemicals and related products were maintained at high levels in April with a number of classes recording gains compared with April last year, according to the Department of Commerce. Total value was reported at $14,658,500 during the month compared with $15,000,000 in March and $14,165,000 in April of last year.

Items recording gains in April compared with the corresponding month of last year included chemical specialties, shipments of which increased in value from $2,508,000 to $2,720,000; industrial chemicals, from $2,269,000 to $2,355,000; essential oils, from $180,250 to $263,250; and paint products including pigments, from $1,465,000 to $1,910,000. Among the pigments, exports of carbon black increased from 15,000,000 lb. to 23,000,000 lb. during the periods under review.

Items recording decreases in April compared with April, 1938 included fertilizers, shipments of which decreased from $1,520,000 to $1,161,000; industrial explosives, from $311,000 to $285,000; soaps, from $252,000 to $205,000; toilet preparations, from $595,500 to $560,000; printing inks, from $77,000 to $64,000; sulphur, both crude and refined, from $1,163,000 to $979,000; and coal-tar products, from $1,024,000 to $990,000.

Imports of chemicals and related products advanced sharply to a total valuation of $19,000,000 in April, the highest valuation recorded in many months. All leading items and classifications of chemicals and related products, particularly coal-tar products, fertilizer materials, gums, resins, and balsams, advanced sharply in April compared with April, 1938.

Imports of coal-tar products were valued at $4,129,000 in April, compared with $1,256,000 a year ago. This sharp gain was due to heavier imports of intermediates which increased from 60,000 lb. to 1,075,000 lb.; and colors, dyes, and stains, from 184,000 lb. to 1,468,000 lb.

CHEM. & MET.

Weighted Index of

CHEMICAL PRICES

Base=100 for 1937

This month	**97.21**
Last month	97.27
June, 1938	99.88
June, 1937	99.88

There was very little change in the average price level last month. Spirits of turpentine was lower but other solvents appear to have reached a bottom level. Tin salts were firmer with the majority of chemicals holding a steady price course.

CHEM. & MET.

Weighted Index of Prices for

OILS AND FATS

Base=100 for 1937

This month	**71.09**
Last month	70.85
June, 1938	72.34
June, 1937	100.28

While values fluctuated generally, the movement was about evenly divided between advances and declines. Most important was the advance in china wood oil which resulted in nominal quotations in the absence of future offerings. Linseed oil advanced on unfavorable Argentine crop developments.

INDUSTRIAL CHEMICALS

Current PRICES

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.05½–$0.06½	$0.05½–$0.06½	$0.05½–$0.06½
Acid, acetic, 28%, bbl., cwt.	2.23 – 2.48	2.23 – 2.48	2.23 – 2.48
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.25 –10.50	10.25 –10.50	10.25 –10.50
Boric, bbl., ton	106.00–111.00	106.00–111.00	105.00–115.00
Citric, kegs, lb	.20½– .23	.20½– .23	.24 – .27
Formic, bbl., ton	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	.70 – .75	.70 – .75	.75 – .78
Hydrofluoric 30% carb., lb	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Muriatic, 18°, tanks, cwt.	1.05 –.....	1.05 –.....	1.05 –.....
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –.....	18.50 –20.00
Oxalic, crystals, bbl., lb.	.10½– .12	.10½– .12	.10½– .12
Phosphoric, c'bys., lb.	.07½– .08½	.07½– .08½	.09 – .10
Sulphuric, 60° tanks, ton	13.00 –.....	13.00 –.....	13.00 –.....
Sulphuric, 66°, tanks, ton	16.50 –.....	16.50 –.....	16.50 –.....
Tannic, tech., bbl., lb.	.40 – .45	.40 – .45	.40 – .45
Tartaric, powd., bbl., lb.	.27½–.....	.27½–.....	.26½–.....
Tungstic, bbl., lb.	2.35 –.....	2.35 –.....	2.75 –.....
Alcohol, Amyl	...–.....	...–.....	...–.....
From Pentane, tanks, lb.	.10½–.....	.10½–.....	.12¾–.....
Alcohol, Butyl, tanks, lb.	.07½–.....	.07¾–.....	.08½–.....
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.54 –.....	4.54 –.....	4.14 –.....
Denatured, 190 proof			
No. 1 special, bbl., gal. wks.	.26½–.....	.26½–.....	.31 –.....
Alum, ammonia, lump, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Potash, lump, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Aluminum sulphate, com. bags, cwt.	1.15 – 1.40	1.15 – 1.40	1.15 – 1.40
Iron free, bg., cwt.	1.30 – 1.55	1.30 – 1.55	1.30 – 1.55
Aqua ammonia, 26°, drums, lb.	.02 – .03	.02 – .03	.02½– .03
tanks, lb.	.02 – .02½	.02 – .02½	.02½– .02¾
Ammonia, anhydrous, cyl., lb.	.15½–.....	.15½–.....	.15½–.16
tanks, lb.	.04½–.....	.04½–.....	.04½–.16
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks, cwt.	1.40 –.....	1.40 –.....	1.475–.....
Amylacetate tech., tanks, lb.	.10½–.....	.09½–.....	.11 –.....
Antimony Oxide, bbl., lb.	.11 – .12	.11 – .12	.12 – .13
Arsenic, white, powd., bbl., lb.	.03 – .03¼	.03 – .03¼	.03 – .03½
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb.	.07 – .08	.07 – .08	.07 – .08
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f. o. b., wks., drums, cwt.	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	48.00 –51.00	48.00 –51.00	46.00 –51.00
Bromine, cs., lb.	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	1.65 –.....	1.65 –.....	1.65 –.....
Arsenate, dr., lb.	.06½– .07	.06½– .07	.06½– .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	21.50 –24.50	21.50 –24.50	21.50 –24.50
flake, dr., del., ton	23.00 –25.00	23.00 –25.00	23.00 –25.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb.	.04½– .05½	.04½– .05½	.05½– .06
Chlorine, liquid, tanks, wks., lb.	1.75 –.....	1.75 –.....	2.15 –.....
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.67 – 1.70	1.67 – 1.70	1.67 – 1.70
Copperas, bgs., f. o. b., wks., ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Copper carbonate, bbl., lb.	.10 – .16½	.10 – .16½	.09 – .16
Sulphate, bbl., cwt.	4.10 – 4.35	4.10 – 4.35	4.00 – 4.25
Cream of tartar, bbl., lb.	.22½– .23	.22½– .23	.21½– .22
Diethylene glycol, dr., lb.	.22 – .23	.22 – .23	.22 – .23
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb.	.061–.....	.061–.....	.06½–.....
Formaldehyde, 40%, bbl., lb.	.05½– .06½	.05½– .06½	.05½– .6½
Furfural, tar ks, lb.	.09 –.....	.09 –.....	.09 –.....
Fusel oil, ref. drums, lb.	.12½– .14	.12½– .14	.12½– .14
Glaubers salt, bags, cwt.	.95 – 1.00	.95 – 1.00	.95 – 1.00
Glycerine, c.p., drums, extra, lb.	.12½–.....	.12½–.....	.15½–.....
Lead:			
White, basic carbonate, dry casks, lb.	.07 –.....	.07 –.....	.06½–.....
White, basic sulphate, sck., lb.	.06½–.....	.06½–.....	.05½–.....
Red, dry, sck., lb.	.07½–.....	.07½ –.....	.06½–.....
Lead acetate, white crys., bbl., lb.	.10 – .11	.10 – .11	.10 – .11
Lead arsenate, powd., bbl., lb.	.10 – .10½	.10 – .10½	.12½– .13
Lime, chem., bulk, ton	8.50 –.....	8.50 –.....	8.50 –.....
Litharge, pwd., csk., lb.	.06½–.....	.06½–.....	1.05½–.....
Lithophone, bags, lb.	.04½– .04¾	.04½– .04¾	.04½– .05
Magnesium carb., tech., bags, lb.	.06 – .06½	.06 – .06½	.06 – .06½

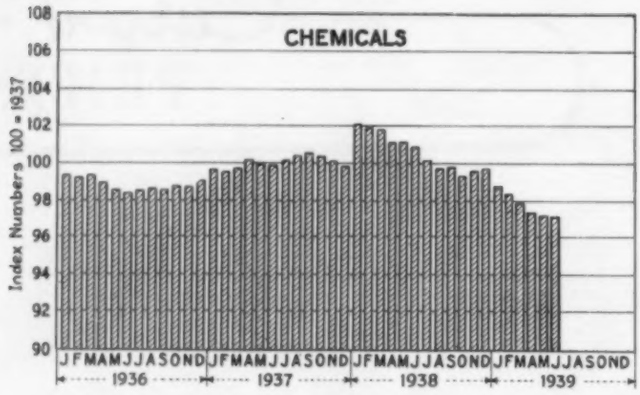
The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to June 14

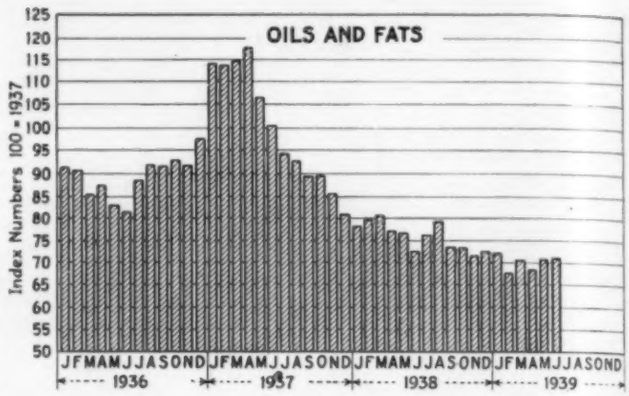
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal.	.31 –.....	.31 –.....	.31 –.....
97%, tanks, gal.	.32 –.....	.32 –.....	.32 –.....
Synthetic, tanks, gal.	.33 –.....	.33 –.....	.33 –.....
Nickel salt, double, bbl., lb.	.13 – .13¼	.13 – .13¼	.13 – .13¼
Orange mineral, csk., lb.	.10½–.....	.10½–.....	.09½–.....
Phosphorus, red, cases, lb.	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb.	.18 – .25	.18 – .25	.24 – .30
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.08½– .09
Carbonate, 80–85%, calc. csk., lb.	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb.	.09½–.....	.09½–.....	.09½–.....
Hydroxide (c'stic potash) dr., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 80% bgs., unit.	.53½–.....	.53½–.....	.53½–.....
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, csks, lb.	.14 – .15	.14 – .15	.15 – .16
Sal ammoniac, white, casks, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.05 –.....	1.05 –.....	1.05 –.....
Dense, bags, cwt.	1.10 –.....	1.10 –.....	1.10 –.....
Soda, caustic, 76%, solid, drums, cwt.	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, works, bbl., lb.	.04 – .05	.04 – .05	.04½– .05
Bicarbonate, bbl., cwt.	1.70 – 2.00	1.70 – 2.00	1.75 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.06½– .07
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Chlorate, kegs, lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Cyanide, cases, dom., lb.	.14 – .15	.14 – .15	.16½– .17
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	2.20 – 3.20	2.20 – 3.20	2.15 – 3.15
Nitrate, bags, cwt.	1.45 –.....	1.45 –.....	1.45 –.....
Nitrite, casks, lb.	.06½– .07	.06½– .07	.07 – .08
Phosphate, dibasic, bags, lb.	1.85 –.....	1.85 –.....	1.85 – .024
Prussiate, yel. drums, lb.	.09½– .10	.09½– .10	.10 – .11
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, crys., bbl., lb.	.02½– .02¾	.02½– .02¾	.02½– .02¾
Sulphur, crude at mine, bulk, ton.	16.00 –.....	16.00 –.....	18.00 –.....
Chloride, dr., lb.	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb.	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.52 –.....	.50 –.....	.44 –.....
Crystals, bbl., lb.	.38 –.....	.38 –.....	.33 –.....
Zinc, chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb.	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb.	.33 – .35	.33 – .35	.36 – .38
Dust, bbl., lb.	.06½–.....	.06½–.....	.06½–.....
Zinc oxide, lead free, bag., lb.	.06½–.....	.06½–.....	.06½–.....
5% lead sulphate, bags, lb.	.06½–.....	.06½–.....	.06½–.....
Sulphate, bbl., cwt.	2.75 – 3.00	2.75 – 3.00	3.15 – 3.60

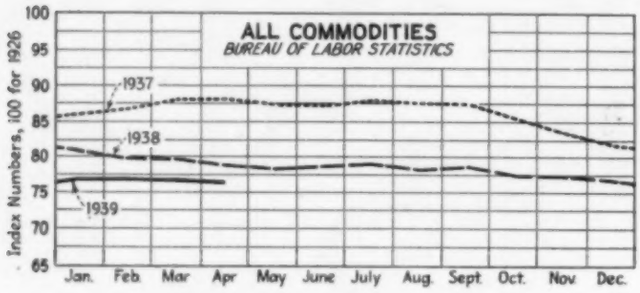
OILS AND FATS

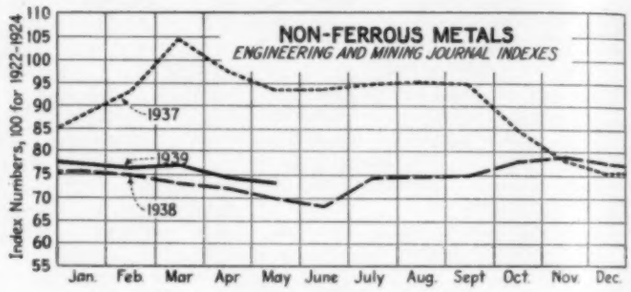
	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb.	$0.08½–$0.10	$0.08½–$0.10	$0.09½–$0.10
Chinawood oil, bbl., lb.	.20 –.....	.17½–.....	.10½–.....
Coconut oil, Ceylon, tank, N. Y., lb.	.03½–.....	.03½–.....	.03½–.....
Corn oil crude, tanks (f. o. b. mill), lb.	.05½–.....	.06 –.....	.07 –.....
Cottonseed oil, crude (f. o. b. mill), tanks, lb.	.05½–.....	.05½–.....	.06½–.....
Linseed oil, raw car lots, bbl., lb.	.09½–.....	.088–.....	.086–.....
Palm, casks, lb.	.03½–.....	.03½–.....	.03½–.....
Peanut oil, crude, tanks (mill), lb.	.05½–.....	.05½–.....	.06½–.....
Rapeseed oil, refined, bbl., gal.	.80 –.....	.80 –.....	.78 –.....
Soya bean, tank, lb.	.04½–.....	.05 –.....	.05½–.....
Sulphur (olive foots), bbl., lb.	.06½–.....	.06½–.....	.07½–.....
Cod, Newfoundland, bbl., gal.	.32 –.....	.32 –.....	.50 –.....
Menhaden, light pressed, bbl., lb.	.066–.....	.066–.....	.07½–.....
Crude, tanks (f. o. b. factory), gal.	.28 –.....	.30 –.....	.35 –.....
Grease, yellow, loose, lb.	.04½–.....	.05 –.....	.04½–.....
Oleo stearine, lb.	.06 –.....	.06½–.....	.07½–.....
Oleo oil, No. 1	.07½–.....	.07½–.....	.08½–.....
Red oil, distilled, d.p. bbl., lb.	.07½–.....	.07½–.....	.08½–.....
Tallow extra, loose, lb.	.05½–.....	.05½–.....	.04½–.....

Chem. & Met.'s Weighted Price Indexes









COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52 –$0.55	$0.52 –$0.55	$0.52 –$0.55
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.15 – .16	.15 – .16	.15 – .16
Aniline, salts, bbl., lb.	.22 – .24	.22 – .24	.22 – .24
Benzaldehyde, U.S.P., dr., lb.	.85 – .95	.85 – .95	.85 – .95
Benzidine base, bbl., lb.	.70 – .75	.70 – .75	.70 – .75
Benzoic acid, U.S.P., kgs., lb.	.54 – .56	.54 – .56	.54 – .56
Benzyl chloride, tech., dr., lb.	.23 – .25	.23 – .25	.25 – .27
Benzol, 90%, tanks, works, gal.	.16 – .18	.16 – .18	.16 – .18
Beta-napthol, tech., drums, lb.	.23 – .24	.23 – .24	.23 – .24
Cresol, U.S.P., dr., lb.	.10 – .11	.10 – .11	.12 – .13
Cresylic acid, dr., wks., gal.	.69 – .71	.69 – .71	.87 – .89
Diethylaniline, dr., lb.	.40 – .45	.40 – .45	.40 – .45
Dinitrophenol, bbl., lb.	.23 – .25	.23 – .25	.23 – .25
Dinitrotoluen, bbl., lb.	.15 – .16	.15 – .16	.15 – .16
Dip oil, 15%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.32 – .36	.32 – .36	.32 – .36
H-acid, bbl., lb.	.50 – .55	.50 – .55	.50 – .55
Naphthalene, flake, bbl., lb.	.05½– .06	.05½– .06	.06½– .07
Nitrobensene, dr., lb.	.08 – .09	.08 – .09	.08 – .09
Para-nitraniline, bbl., lb.	.47 – .49	.47 – .49	.50 – .52
Phenol, U.S.P., drums, lb.	.14½–.....	.14½–.....	.14½–.....
Picric acid, bbl., lb.	.35 – .40	.35 – .40	.35 – .40
Pyridine, dr., gal.	1.55 – 1.60	1.55 – 1.60	1.55 – 1.60
Resorcinal, tech., kegs, lb.	.75 – .80	.75 – .80	.75 – .80
Salicylic acid, tech., bbl., lb.	.33 – .40	.33 – .40	.33 – .40
Solvent naptha, w.w., tanks, gal.	.26 –.....	.26 –.....	.26 –.....
Tolidine, bbl., lb.	.86 – .88	.86 – .88	.88 – .90
Toluene, tanks, works, gal.	.27 –.....	.26 –.....	.26 –.....
Xylene, com, tanks, gal.	.26 –.....	.26 –.....	.25 –.....

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.08½– .11	.07 – .11	.07½– .12
China clay, dom., f.o.b. mine, ton.	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors			
Carbon gas, black (wks.), lb.	.02½– .30	.02½– .30	.02½– .30
Prussian blue, bbl., lb.	.36 – .37	.36 – .37	.36 – .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.10 – .26
Chrome green, bbl., lb.	.21 – .30	.21 – .30	.21 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.75 – .80	.75 – .80	.75 – .80
Vermilion, English, bbl., lb.	1.57 – 1.58	1.57 – 1.58	1.45 – 1.50
Chrome yellow, C.P., bbl., lb.	.14½– .15½	.14½– .15½	.14½– .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.06 – .06½	.06 – .06½	.06 – .06½
Gum copal Congo, bags, lb.	.06 – .30	.06 – .30	.08 – .30
Manila, bags, lb.	.07 – .14	.07 – .14	.09 – .14
Damar, Batavia, cases, lb.	.16 – .24	.16 – .24	.16 – .24
Kauri cases, lb.	.17½– .60	.17½– .60	.18½– .60
Kieselguhr (f.o.b. N. Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton	50.00 –.....	50.00 –.....	50.00 –.....
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .04	.03 – .04	.03 – .04
Rosin, H., bbl.	6.35 –.....	6.35 –.....	5.65 –.....
Turpentine, gal.	.29½–.....	.30½–.....	.28½–.....
Shellac, orange, fine, bags, lb.	.19 –.....	.19 –.....	.20 –.....
Bleached, bonedry, bags, lb.	.18 –.....	.18 –.....	.17 –.....
T. N. Bags, lb.	.10 –.....	.10 –.....	.11 –.....
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 –.....	13.75 –.....	13.75 –.....

INDUSTRIAL NOTES

REYNOLDS MOLDED PLASTICS, Jackson, Mich., has opened a sales office in the Hanna Bldg., Cleveland with Robert R. Wilson in charge.

ROBINS CONVEYING BELT CO., New York, has transferred R. W. Eichenberger, vice-president, from the Chicago office to the general office, 15 Park Row, New York.

THE RESISTOFLEX CORP., has moved its executive offices from New York to Belleville, N. J. and has also moved its plant from Dover, N. J. to Belleville.

AJAX FLEXIBLE COUPLING CO., Westfield, N. Y. has appointed The Chicago Pulley & Shafting Co., Chicago, as distributor of its couplings.

BUFFALO FOUNDRY AND MACHINE CO., Buffalo, has promoted Edward V. Hegg to the position of manager of the New York office.

GREAT LAKES CARBON CORP., New York, will construct a plant at Niagara Falls for the manufacture of carbon and graphite electrodes. Construction and operation of the plant will be under the supervision of B. E. Broadwell.

HARDINGE CO., York, Pa., has added Bertrand Robinson to its engineering and sales staff. Mr. Robinson will represent the company in eastern Canada with headquarters in Toronto.

WORTHINGTON PUMP AND MACHINERY CORP., Harrison, N. J., has elected H. C. Beaver as a vice-president. Mr. Beaver joined the corporation in 1915 and for the past 10 years has been manager of the works in Buffalo.

BRIGGS & STRATTON CORP., Milwaukee, who has been making the variable speed transmission for Graham Transmissions, Inc., has become exclusive licensees for the manufacture and sale of these transmissions.

New CONSTRUCTION

	Current Projects		Cummulative 1939	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$50,000	$125,000	$1,085,000	$1,275,000
Middle Atlantic	395,000	349,000	3,285,000	9,563,000
South	.....	50,000	7,733,000	8,625,000
Middle West	10,220,000	380,000	12,870,000	905,000
West of Mississippi	275,000	1,640,000	2,110,000	2,810,000
Far West	500,000	.....	4,620,000	1,451,000
Canada	550,000	1,225,000	5,500,000	3,340,000
Total	$11,990,000	$3,769,000	$37,203,000	$27,969,000

PROPOSED WORK

Aluminum Plant—Georges L'Hoir Co., Angleur-le-Leige, Belgium, c/o C. Vallancourt, 63 Ste Anne St., Quebec City, Que., Can., plans to construct an aluminum plant at Levis, Que. Estimated cost $300,000.

Brick Factory—Stanley Works, 195 Lake St., New Britain, Conn., will soon award the contract for the construction of a 2 story, 50x60 ft. addition to its factory. Maxwell Moore & Charles Salisbury, 967 Farmington Ave., West Hartford, Conn., Archts. Estimated cost $50,000.

Charcoal Plant—Union Charcoal Co., Sheffield, Pa., plans to rebuild its 3 story charcoal manufacturing plant and warehouse recently destroyed by fire. Daniel Howard, Supt. Estimated cost $50,000.

Creosoting Plant—Canada Creosoting Co., Ltd., 606 Cathcart St., Montreal, Que., Can., plans to construct a factory at Port Arthur, Ont. Estimated cost $200,000.

Gas Plant—City, Waverly, Ia., contemplates the construction of a gas plant.

Kiln—M. D. Valentine & Bros. Co., 164 Fulton St., Woodbridge, N. J., plans to construct a firebrick kiln, 300 ft. long, 5 ft. wide and 10 ft. high, including equipment. Harrop Ceramic Service Co., 965 West 5th St., Columbus, O., Engr. Estimated cost $60,000.

Chemical Laboratory—G. F. Harvey Co., Wells St., Saratoga Springs, N. Y., will soon receive bids for the construction of a 2 story, 45x54 ft. chemical laboratory.

Chemical Laboratory—Sunbeam Electric Co., J. Howard Denny, Vice Pres. in charge of engineering, Read and Morgan Sts., Evansville, Ind., is having plans prepared by E. C. Berendes, Archt., 121 N.W. 4th St., Evansville, for the construction of a 2 story, 55x200 ft. addition to its plant to be used for chemical and metallurgical laboratories. Estimated cost $75,000.

Research Laboratory—Texas Co., 135 East 42nd St., New York, N. Y., plans to construct a research laboratory near Beacon, N. Y. D. W. Carswell, c/o owner, Engr. Estimated cost will exceed $40,000.

Smokeless Fuel Laboratory—State of Illinois, Springfield, Ill., plans to construct a smokeless fuel laboratory building at Urbana, Ill. Estimated cost $95,000.

Liquid Carbonic Factory—Liquid Carbonic Corp., Ltd., 525 Archibald St., St. Boniface, Man., Can., plans to construct an extension to its factory. Estimated cost $50,000.

Oil Refinery—B. Franklin et al, Kilgore, Tex., contemplates the construction of an oil refinery near Henderson, Tex. Estimated cost $150,000.

Oil Refinery—Shell Union Oil Co., Hammond, Ind., plans to convert its Roxana refinery at Hammond into a terminal distributing point for gasoline and construct a new refinery at Wood River, Ill. Estimated cost $10,000,000 or more.

Recycling Plant—J. J. Sheer, 700 Olmos Dr., E., San Antonio, Tex., R. T. Wilson, Amarillo, Tex., and Clyde Alexander, Dallas, Tex., associates, plan to construct a 70,000,000 ft. recycling plant near Agua Dulce, Tex.

Paper Plant—Union Bag & Paper Corp., John St., Hudson Falls, N. Y., plans to construct a 2 story, 100x100 ft. addition to its plant.

Pipe Line—Coltex Refining Co., Snyder, Tex., plans to install 30 mil. of 4 to 6-in. screw joint steel pipe line from point near Westbrook to Sharon Pool. Estimated cost $45,000.

Rubber Factory—Swan Rubber Co., Bucyrus, O., plans to construct two new units at its factory. Estimated cost will exceed $50,000.

Veneer Factory—Washington Veneer Co., foot Capitol Wharf, Olympia, Wash., plans to construct a veneer factory near Springfield, Ore. Estimated cost $500,000.

Warehouse—National Gypsum Co., 190 Delaware Ave., Buffalo, N. Y., plans to construct a warehouse at Cabot St. and Oak Point Ave., New York, N. Y. Estimated cost $125,000.

Warehouse—Penna Distillery Co., M. R. Werner, Pres., Logansport, Pa., contemplates the construction of a 4 or 5 story warehouse.

CONTRACTS AWARDED

Aluminum Factory—Aluminum Co. of Canada, Ltd., 1010 Ste. Catherine St., W., Montreal, Que., Can., has awarded the contract for an aluminum factory to Anglin-Norcross, Ltd., 892 Sherbrooke St., W., Montreal, at cost plus basis, $1,000,000.

Carbon Electrode Plant—Great Lakes Carbon Corp., South Michigan Ave., Chicago, Ill., has awarded the contract for a plant to Walter S. Johnson Bldg. Co., 2532 Hyde Park Blvd., Niagara Falls, N. Y. Estimated cost will exceed $40,000.

Chemical Plant—American Cyanamid & Chemical Corp., L. R. Verdon, Mgr., Miller Rd., Kalamazoo, Mich., has awarded the contract for a chemical plant to Miller-Davis Co., Kalamazoo. Estimated cost $300,000.

Chemical Plant—Schering Corp., 86 Oregon St., Bloomfield, N. J., has awarded the contract for three plant buildings to Walter Kidde Construction Co., 140 Cedar St., New York, N. Y. Estimated cost $150,000.

Chemical Plant—Smith Chemical Co., c/o F. E. Smith, Harlingen, Tex., will construct a chemical plant. Work will be done by day labor. Estimated cost will exceed $40,000.

Laboratory—Julien P. Friez Division, Bendix Aviation Corp., Baltimore, Md., has awarded the contract for a laboratory and office building to Consolidated Engineering Co., 20 East Franklin St., Baltimore. Estimated cost $158,950.

Liquid Air Factory—Liquid Air Co., York St., E., London, Ont., Can., has awarded the contract for a 40x65 ft. addition to its factory to Hyatt Bros., 288 Egerton St., London, Ont. Estimated cost $35,000.

Oil Refinery—Consumers Cooperative Assn., 15th and Iron Sts., North Kansas City, Mo., has awarded the contract for an oil refinery and pipe line at Phillipsburg, Kan., to Mid-Continent Engineering Co., Frost Natl. Bank Bldg., Dallas, Tex. Estimated cost $700,000.

Oil Refinery—Mid Continent Petroleum Corp., Tulsa, Okla., has awarded the contract for a lubricating oil refinery, still, tanks, boilers, etc., to M. W. Kellogg Co., 225 Bway., New York, N. Y. Estimated cost $800,000.

Record Factory—American Record Co., Barnum Ave., Bridgeport, Conn., has awarded the contract for alterations and improvements to its record manufacturing plant, also laboratory equipment, to W. J. Barney Corp., 101 Park Ave., New York, N. Y. Estimated cost $125,000.

Rubber Factory—Continental Rubber Works, 1902 Liberty St., Erie, Pa., have awarded the contract for a 3 story, 62x73 ft. rubber factory to Henry Shenk Co., 1115 Sassafras St., Erie.

Rubber Factory—Goodyear Tire & Rubber Co., 144 East Market St., Akron, O., has awarded the contract for a 4 story mill building at Gadsden, Ala., to A. K. Adams Co., 542 Plum St., N. W., Atlanta, Ga.

Soap Factory—Lever Bros., Ltd., 299 Eastern Ave., Toronto, Ont., Can., has awarded the contract for a 3 story, 80x140 ft. addition to its factory to Milner & Nicholls, 57 Bloor St., W., Toronto. Estimated cost $150,000.

Sugar Refinery—British Columbia Sugar Refining Co., foot Rogers St., Vancouver, B. C., Can., has awarded the contract for an addition to its refinery to Dominion Construction Co., Granville St., Vancouver. Estimated cost $40,000.

Tile Factory—Pence Tile Works, Inc., c/o F. K. Pence, Pres., 1111 South Texas Bank Bldg., San Antonio, Tex., will construct a tile manufacturing factory in the vicinity of Devine and LaCoste, Tex., near San Antonio. Work will be done by day labor and subcontracts. Estimated cost $100,000.

Warehouse—Sunnyside Oil Co., 2212 Sunnyside Ave., Chicago, Ill., has awarded the contract for a warehouse to Ockerlund Construction Co., 4911 North Lincoln Ave., Chicago.

TARIFF COMMISSION REPORTS DROP IN OUTPUT OF DYES AND SYNTHETIC CHEMICALS

THE Tariff Commission has issued preliminary statistics of production and sales of synthetic organic chemicals in 1938. Sales of synthetic organic chemicals decreased 13 per cent, from $284,000,000 in 1937, a year of peak chemical sales, to $246,000,000 in 1938. The decline in coal-tar chemicals was 21 per cent, from $164,000,000 in 1937 to $130,000,000 in 1938, and in non-coal-tar synthetics 3 per cent, from $119,000,000 in 1937 to $116,000,000 in 1938. The groups that were off the most in sales value are coal-tar resins and dyes. Sales of non-coal-tar resins increased.

Unit values of some groups, particularly dyes, medicinals, and non-coal-tar resins, were higher in 1938 than in 1937. The principal factor in such increases was the relatively greater sales of higher-priced items within the groups. The decrease in unit value of the flavors and perfume materials group was due primarily to substantial price reductions on several large items.

The generally greater decline in production than in sales indicates that during 1938 producers of synthetic organic chemicals reduced inventories carried over from 1937.

A substantial part of the output of synthetic organic chemicals is consumed by the producers in further processing. This is especially the case in certain groups. More than half of the coal-tar intermediates, and non-coal-tar chemicals, and about a fifth of the coal-tar resins and medicinals are consumed by the producing concerns.

Production of 402,000,000 lb. of coal-tar intermediates in 1938 was 30 per cent under that in 1937. Phenol and phthalic anhydride, both used in large quantities in manufacturing synthetic resins, were off 32 per cent and 39 per cent, respectively, in output. The basic commodities, aniline oil and refined naphthalene, were down almost as much. Contrary to the general trend, the 13,000,000 lb. of p-dichlorobenzene made in 1938 was almost 12 per cent more than in 1937.

The output of 81,000,000 lb. of dyes is 33 per cent less than in 1937. Sales decreased 26 per cent in quantity and 18 per cent in value. Sales of unclassified dyes, continuing to increase in importance, were 32 per cent of the sales value of all dyes as compared with 30 per cent in the preceding year. Outstanding changes in the dye trade in 1938 were decreases in sales of sulphur black from 14,000,000 lb. in 1937 to 8,000,000 lb. in 1938, and of synthetic indigo from 18,000,000 lb. to 12,000,000 lb. during the same period. Drastic curtailment in our dye export trade with China is a primary cause of the lessened sales of these and similar cheap, bulk colors.

The decline in synthetic resins was in those of coal-tar origin, which were 25 per cent less in production, 107,000,000 lb. in 1938, and 23 per cent less in value of sales, $16,000,000 in 1938, than in 1937. Non-coal-tar resins increased 11 per cent in production to 23,000,000 lb., and 24 per cent in value of sales to $7,000,000, partly as a result of commercial production of the relatively high-priced vinyl acetals for use in safety glass manufacture. Resins derived from urea are shown separately for the first time.

Synthetics for use in compounding rubber were off about a third in output; accelerators declined more than did other rubber chemicals. In the miscellaneous coal-tar chemicals group, photographic chemicals increased slightly in production, and sales value. The output of textile chemicals was 6,000,000 lb., 83 per cent more than in 1937. Sales increased proportionately. The production of 10,000 lb. of phthalates in 1938 was 31 per cent less than in the preceding year.

Output of miscellaneous non-coal-tar synthetics in 1938 was 2,383,000,000 lb., 5 per cent less than in 1937. The decrease in production of acetic acid was 22 per cent and of acetic anhydride 35 per cent. Sales of acetone were slightly less than in 1937. Butyl alcohol was off 35 per cent in production. The steady upward trend in carbon tetrachloride production was broken in 1938 when the output decreased 7 per cent. Isopropyl alcohol increased 7 per cent in production.

Synthetic Organic Chemicals, 1937 and 1938

Coal-tar chemicals		1937	1938
Intermediates:			
Production	1000 lb.	575,893	401,943
Sales	1000 lb.	242,194	171,514
Sales value	$1000	35,639	26,090
Finished coal-tar products: [1]			
Production	1000 lb.	[2] 373,063	275,203
Sales	1000 lb.	[2] 315,742	244,066
Sales value	$1000	[2] 128,736	103,709
Dyes:			
Production	1000 lb.	122,245	81,326
Sales	1000 lb.	118,046	87,284
Sales value	$1000	64,613	53,011
Medicinals:			
Production	1000 lb.	14,800	11,097
Sales	1000 lb.	11,989	8,885
Sales value	$1000	11,496	9,509
Flavors and perfume materials:			
Production	1000 lb.	4,356	3,795
Sales	1000 lb.	3,907	3,618
Sales value	$1000	3,983	3,283
Coal-tar resins:			
Production	1000 lb.	[2] 142,025	106,923
Sales	1000 lb.	[2] 109,201	84,763
Sales value	$1000	[2] 20,582	15,811
Non-coal-tar chemicals			
Production	1000 lb.	2,529,650	2,409,418
Sales	1000 lb.	1,168,149	1,121,569
Sales value	$1000	119,420	115,933

[1] Includes color lakes, rubber chemicals and miscellaneous coal-tar products not shown separately.
[2] Does not include resins from adipic acid, coumarone and indene, hydrocarbons, styrol, succinic acid and sulfonamides.

Production and Sales of Certain Miscellaneous Synthetic Chemical Products, 1938

	Production	Sales		
	Lb.	Lb.	Value	Unit value
Coal-tar Total	**39,424,372**	**32,735,729**	**$7,382,406**	**$0.23**
Photographic chemicals: Total	1,800,207	1,415,911	1,585,051	1.12
Hydroquinol	1,246,671	1,123,063	968,820	.86
Methyl p-amonophenol sulfate (metol) (rhodol)	214,628	215,462	536,116	2.49
Phthalates: Total	10,428,947	8,149,826	1,658,749	.20
Dibutyl	4,206,475	3,346,921	606,536	.18
Diethyl	870,283	746,975	135,174	.18
Textile chemicals: Total	5,622,096	4,769,154	1,123,890	.24
Non-coal-tar Total [1]	**2,383,167,683**	**1,102,108,069**	**105,882,717**	**.10**
Acetic acid (100% purity)	97,478,563	.....	.....	.....
Acetic anhydride (from all sources) (100% purity)	114,835,504	.....	.....	.....
Acetone	.....	67,041,184	2,887,374	.04
Amines (mono, di, tri)	302,053	228,388	115,542	.51
Amyl acetates, total	5,828,497	6,393,792	679,398	.11
Amyl alcohols, total	9,096,977	.....	.....	.....
Butyl acetates, total	55,792,217	43,334,733	3,571,662	.08
Butyl alcohols, total	81,304,789	30,220,372	2,376,175	.08
Carbon tetrachloride	77,975,057	70,383,429	2,860,288	.04
Chloroform (tech and USP)	2,159,933	1,788,816	327,198	.18
Citric acid, refined (fermentation)	10,277,234	10,406,354	2,421,922	.23
Diacetone alcohol	2,382,481	1,776,275	163,272	.09
Dibutyl tartrate	11,980	14,294	6,461	.45
Ethyl acetate (85% purity)	55,725,726	42,373,680	2,322,761	.05
Gallic acid, tech	140,625	74,933	52,263	.70
Isopropyl alcohol (Isopropanol)	141,081,915	17,190,575	705,585	.04
Isopropyl ether	.....	1,548,530	62,750	.04
Lactic acid: Edible (100%)	1,292,216	984,152	209,846	.21
Methanol (synthetic)	.....	98,157,826	3,784,435	.04
Methyl chloride (Chloromethane) (100% purity)	3,064,227	3,041,642	954,267	.31
Methyl formate	.....	41,639	11,045	.27
Oxalic acid	9,194,738	9,007,950	901,369	.10
Pyrogallic acid (Pyrogallol)	51,324	48,958	69,281	1.42
Sulfated fatty alcohols, acids, etc. (Gardinols, Igepons, Intramines)	7,668,458	.....	.....	.....

[1] Includes non-coal-tar rubber chemicals.